THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Bradford Electricity Supply	623
The St. James's and Pall Mall Company's Mains	624
Gutta-Percha	625
The Electric Light at Bangkok	626
Does Ohm's Law Hold True for Alternating Currents of High Tension and High Frequency	626
Relative Weights and Cost of Dynamos (*illustrated*)	628
Dinner and Testimonial to Prof. Ayrton	630
Electrical Distribution by Alternating Currents and Transformers (*illustrated*)—(*continued*)	631
Difficulties of an Electric Tramline	632
Project of an Electrical Tramway between St. Moritzdorf and St. Moritzbad	632
Utilisation of Water Power in Switzerland	632
The Practical Limits of High Potential for the Transmission of Power	633
High Potential Phenomena (*illustrated*)	634
Electricity as Applied to Torpedo and other Naval Purposes ...	635
Proceedings of Societies:—Institution of Electrical Engineers	636
Electric Lighting at Amsterdam	640
Electric and Cable Railways in the Metropolis	640
Legal	643
Notes	643
Business Notices, &c.	648
City Notes, &c.:—Chelsea Electricity Supply Company ...	648
West India and Panama Telegraph Company	649
Traffic Receipts	649
Share List of Electrical Companies	650
Gutta-percha	651
New Patents	651
Abstracts of Published Specifications	652
Correspondence:—Mercurial Poisoning	652
Crystal Palace Electrical Exhibition (*illus.*)—(*continued*) ...	653

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THE BRADFORD ELECTRICITY SUPPLY.

IN the last number of the *Journal* of the Society of Arts, there appears a letter from Mr. Shoolbred replying to some of the statements made by the chairman (Mr. Preece) at the conclusion of the discussion of the paper on the "Bradford Corporation Electricity Supply." The two points referred to in this letter relate to the utility of stating the total number of lamps fixed, and to the relative values of continuous and alternating currents. With regard to the former, there appears to be a misunderstanding on Mr. Shoolbred's part as to the reason for wishing to know the total number of lamps on the circuits, since his arguments are all directed against estimating the output of the station in terms of the number of lamps of 8 candle-power connected to the mains. So far as we are aware, no one would object to the information being given in terms of lamps of other candle-power, or in ampères or watts of output, so long as the desired result can be obtained, that is, the ratio between the actual maximum output of the station, and the output which would be required if all the lamps, &c., connected to the mains were in operation at one and the same time. That this ratio should be known and studied is most important, as Mr. Bailey pointed out, for it forms an excellent guide as to how far it is safe to go on connecting lamps without increasing the plant, in view of occasional extraordinary demands on dark and foggy days.

With regard to the second point, Mr. Preece's statements that for motive power alternating are more economical than continuous currents, and that they are equally applicable for charging batteries and depositing metals if only a commutating device is introduced into the circuit, will require to be confirmed by actual practice on supply companies' circuits before they are accepted as correct. But though we do not share Mr. Preece's sanguine views on these subjects, we certainly must agree with him in his protest against the summary manner in which the question of the relative advantages of the direct and alternating current systems was disposed of in the paper; since we consider that Mr. Shoolbred is equally sanguine when he refers to the facility with which the low pressure system can be carried out throughout the area of five miles by three occupied by the town of Bradford, and still more so when he speaks of extending it to districts outside the borough. Facilities for such extensions are more important in this undertaking than in some others, because it is a municipal one; and although the feeling of jealousy of the favoured district may not be very serious so long as the lighting scheme is not a burden on the rates, yet it is absurd to maintain that all the ratepayers are treated on an equality, for the question of extension is in their own hands, and they can be supplied with current so soon as a sufficient number in any district come forward to guarantee a revenue. Mr. Shoolbred must be well aware that

the expenditure which would have to be incurred to supply current for 500 lamps or so to customers situated say two miles from the station, would be so enormously greater than that required for a similar supply to a part of the town just outside the compulsory area, that there is no doubt that the ratepayers in the latter district would get their supply more easily than those in the former, and that there would, therefore, be no real equality of treatment.

There are two other matters mentioned in the paper and discussion to which we wish to refer, the first being the material financial gain which is expected from the increasing demand for motive power. A reference to the load diagrams published with the paper will, we think, show that this is to a great extent a delusive advantage, since in winter the present maximum demand appears to be between the hours of four and five o'clock, at which time motors or other apparatus for industrial applications would also be running, and therefore the capacity of the generating plant would have to be increased to meet the larger maximum demand, whilst earning a greater revenue only during the hours when industrial processes are in operation.

The other point is the insulation resistance of the circuits, which appears to us low, when we consider the comparatively small number of lamps attached, and that only a part of these were in circuit when the measurements were made. It is unfortunate that the conditions of a continuous supply render it difficult to obtain figures separately for the mains, as although a high insulation resistance *per se* is not of so much importance, such figures would be most useful, as giving information concerning the permanency of the insulation. One of the objections to fibrous insulation is that it depends so entirely on the watertightness of the lead covering, and on the sealing of ends connected to switchboards, terminals, &c.; and it would be interesting to learn how the present insulation of the mains, when disconnected from other sources of leakage, compares with that given by the cables before they were laid, which was, according to the figures quoted by Mr. Preece in his recent paper on "Insulated Conductors," decidedly high, varying from about 2,500 to over 6,000 megohm miles at 60° Fahr., according to the size of the conductor.

THE ST. JAMES'S AND PALL MALL COMPANY'S MAINS.

The report presented to the Board of Trade by Major Cardew respecting certain defects which have developed in the system of bare copper mains employed by the St. James's and Pall Mall Company, is an interesting record of the vagaries that may be played even by the harmless low pressure current when the insulation of the conductors is imperfect. It appears from the report that in September last two explosions occurred, due to accumulations of gas and water respectively, a faulty pilot wire being the immediate cause of the explosion of gas; and that tests, which were made soon afterwards at the suggestion of Major Cardew, showed that there was a serious earth connection on the negative main, the difference of potential between the positive main and earth being about 190 volts instead of 110 volts, which it should have been if the two sides of the circuit had been equal in insulation.

This earth connection seems to have defied the efforts of the company to remove it, and continued to exist until early in April, when it was removed during the operations consequent on the enquiry into the cause of the damage done to a gas meter and to two water pipes, this damage being the subject of the present report by Major Cardew. The failure of a water pipe was first reported, and as it was stated that electric shocks were received on touching a tap in metallic connection with this pipe, and as the main of the London Electric Supply Company passes near, the first suspicion fell on it. An examination proved, however, that the high pressure main was not at fault, as it was found to be in very good order, and that no shock could be obtained from the outer casing; and attention was therefore turned to the low pressure direct current mains, as it was thought that the damage done to the water pipe was very probably due to electrolytic action. At this time attention was drawn to the state of a gas meter, through the back of which two holes had been eaten at points where it was in contact with a damp wall, and as there were no signs of corrosion on any other part of the meter, its appearance seemed to point again to electrolytic action. The next day it was reported that a water pipe had again failed, and when the ground was opened up to remove this pipe which passed under the electric culvert, a test was made, which showed that there was a difference of potential of about six volts between them, which was a sufficient explanation of the cause of the damage.

The culvert was then opened, and was found to contain a good deal of water, and it was further discovered that some lead covered wires which had been used as pilot wires were badly fused, and that they were probably forming the connection between the culvert and the negative main. Major Cardew accounts for the action on the pipes by pointing out that the general insulation of the positive side of the circuit was not high, and that the aggregate leakage current from the positive side first found its way to the gas and water pipes as the best earth, and then from them to the negatively charged culvert across the paths of least resistance, and that the electrolytic action of this current corroded the metal of the pipes and meter. The fact that the meter and not the gas pipe connected with it was damaged, is explained by the protection afforded to the pipe through its being laid in bitumen, so that the circuit from the meter through the damp wall formed an easier path for the current.

Major Cardew concludes by saying, "The steps to be taken by the Board of Trade to provide against the recurrence of similar faults and their consequences will, I think, require very mature consideration; but I have no hesitation in recommending that the company should, without further delay, remove every portion of the pilot wires from the culverts, and should test throughout their system of culverts for the existence of any appreciable difference of potential between the iron culverts and the gas and water pipes." We think too much stress is laid on the presence of pilot wires in the culverts, as after all, no explanation is given of how they came to be in the fused condition in which they were found; and unless there is something peculiar to this system of mains which makes the strains on the pilot wires unusually great, we do not see how there

should be more difficulty or danger in working with them inside the culvert than there is in using properly insulated cables laid in iron pipes.

As to the general question of leakage, the great disadvantage of the low pressure direct current system is that, of necessity, there must be a considerable general leakage, due to the fact that all the house installations are in direct connection with the mains; and this not only makes the chance of danger from a local fault much greater, but also makes it more difficult to trace out such a fault, because it is by no means easy to separate the local leakage from the general leakage until the former has become practically a dead earth. The fact that the company were for some months unable, as we are told in the report, to remove the fault on the negative main, is a strong argument in favour of some change in the system, which will permit of the mains being divided up into short sections, which can be isolated from the rest of the circuit without interfering with the general supply, so as to allow of periodical testing for faults, and, when necessary, of repairing them, with the smallest amount of inconvenience to the customers connected up to the mains.

GUTTA-PERCHA.

IN another part of this issue we publish a translation of an account, which recently appeared in *L'Industrie Electrique*, of a paper read before the Société d'Encouragement by Mr. Sérullas. Acting on the suggestion of Mr. Yungfleisch, and assisted by the above-mentioned Société, Mr. Sérullas has been to Malay, and there conducted a number of experiments in extracting gutta-percha from the leaves of the *Isonandra Gutta* instead of from the trunks of the trees, as is customary by the natives of the country. His results appear to have been satisfactory beyond all expectation. He states that from trees which, if treated in the usual way, would yield, at the sacrifice of their lives, only about 4 ozs. of gum, a quantity of leaves equivalent to a weight of 200 lbs. when dried, can be gathered without permanent injury to the tree every six months. From this 200 lbs. of dry leaves 8 or 9 per cent. of gum can be extracted by the process suggested by Mr. Yungfleisch, and this gum is proved in the laboratory to be gutta-percha of a very pure and homogeneous quality.

In other words, the yield per adult tree is 32 or 36 lbs. per annum instead of ½ oz., as at present, 12 or 15 years being allowed for a tree to grow up again after having been felled. Under the new system of extracting the gum old decayed trees, from the trunks of which no juice could possibly be obtained, are made to yield quite half as much gum as large healthy ones, while from a tree of only four or five years' growth 9 ozs. of gum can be extracted at one gathering of the leaves.

Mr. Sérullas proposes to establish large plantations of trees which, as soon as old enough, will be pollarded, thus facilitating the gathering of the leaves. In the meantime he points out that there is ample scope for operations on old trees, which to the native are useless, and he suggests that a French company should at once be started with the object of rescuing the electrical industry from its impending crisis and breaking down the present foreign monopoly of gutta-percha.

A Motor without an Air-gap.

A DEPARTURE in dynamo and motor design, which, however, is not altogether new, has recently been introduced by Prof. Sidney H. Short, of Cleveland, U.S. The professor has concluded that the air space between the armature and field iron—the *entre fer* as the French graphically call it—may be done away with in spite of Messrs. Esson, Swinburne and others, who claim a definite necessity for the gap. A brief description of the practical points of the invention will be worth attention; for should the design be practicable, a very great improvement in tramway motors is at once before us. We may state though, that our esteemed contemporary, the *Western Electrician*, from whose pages we draw our information, does not state a workable motor has been built on these lines; but only gives drawings showing the application to a tramcar. The chief point lies in the periphery of the armature forming the *journal*, and the bore of the pole pieces the *bearing*, proper lubrication being arranged. The construction of the armature is similar to that of a Pacinotti ring or drum with the wires sunk below the surface, and the whole of the periphery is covered with thin insulation. Outside this is arranged an *iron* ring held in position by screws tapped into the projections of the core. In this ring grooves are turned for holding the lubricant, which is supplied through rubbing-brushes or wicks. One of the advantages claimed for this method of journalling the armature is, that outside bearings are not required, and hence the whole machine can be made much shorter than with the ordinary devices—this a most important point in gearless tramcar motors. And, further, Prof. Short says "that by dispensing with the air space and allowing the armature to run in contact with the fields, the magnetic resistance of the interpolar space is diminished, and through the increase in the relative number of lines of force passing through the armature, the field magnets can be reduced in size and be excited with a less number of ampère turns, although exercising an equal effect in the machine." We do not wish to discourage the professor, but there seems to be a "nigger" somewhere. What about the cross magnetisation and sparking? Would not a brass ring improve matters?

Inductor Alternators.

THERE appears to be an inexplicable attraction about the inductor type of alternator. Ever and anon a fresh designer enters the field and gives the expectant world a nine day's wonder; but little ever comes of it. We suppose the primary attraction lies in stationary windings in both field and armature coils, and the absence of a collector. It may reasonably be doubted whether the device offers any theoretical advantage from the weight-output point of view. For the induced E.M.F. is only proportional to the variations of the magnetic resistance of the circuit, consequent on changes of relative positions between the revolving inductor and the field poles; and may vary between such limits as 10,000 and 5,000 magnetic lines of force per square centimetre. The armature E.M.F. under these conditions would therefore be due to a field of about 5,000 lines. Such a density could be easily exceeded in a well designed alternator of ordinary type with or without iron in the armature; and if iron be excluded a much higher density, and consequently E.M.F. is attainable. These remarks apply equally to the Kingdon, Mordey, Elihu Thomson, and Rankin Kennedy expositions of the principle. Messrs. Pyke and Harris have recently devised a modified form which appears to be inferior, owing to complication of details, multiplicity of parts and lack of mechanical strength when compared with the more simple design of Mordey and Elihu Thomson. Mordey has abandoned his inductor in favour of the alternator now associated with his name. Prof. Thomson, we understand, has built several large machines for central station lighting on his plan; and the Kingdon dynamos have been run in this country for sometime with varied success. The heating of the field magnet cores must always be a source of trouble; but mechanical considerations undoubtedly chiefly explain why these machines have not met with much favour, and possibly there is some fundamental difficulty in running parallel with inductor dynamos We should be glad to hear more on this point.

THE ELECTRIC LIGHT AT BANGKOK.

[FROM OUR OWN CORRESPONDENT.]

From the capital of the Siamese kingdom there arrives remarkable intelligence as to the position of electric lighting in that city. Last year there was founded at Bangkok a company for electric lighting bearing the name "The Siam Electric Light Company," which was, in the first place, to erect electric works at Bangkok, and to supply not only the public lighting, but also to undertake that of the palaces, hotels, private houses, &c. The share capital, which was fixed at 6,000 shares of 80 ticals each (2 ticals = 1·20 dollars = about 5s.), was taken up within three days, and was, in fact, paid up in full.

The newly founded company, as soon as organised, proceeded at once to the erection of the projected electric works, which were to be carried out on the alternating transformer system, and were to be supplied by the London Brush Company. The works were accordingly executed, and five Victoria-Mordey alternating current machines supplied, each of 120 kilowatts, and for their propulsion, five Victoria compound condensing steam engines, with discs for driving, five patent safety tube boilers, two duplex feed water pumps, two condensers with circulating pumps, and all the accessory apparatus, electrical and mechanical, in the central station; further, 330 transformers of different sizes, each of from ¾ to 12 kilowatts, with a total capacity of 650 kilowatts; all the required material for the leads of about 230,000 yards in length, with the necessary supports, insulators, &c., in short, everything needed for the equipment of complete electrical works, together with a very ample stock of reserve parts, glow lamps, &c. The cost of this complete installation amounted to rather more than £40,000, to which were to be added the spacious machine and boiler houses and dwellings for the staff, erected by the Siam Company on its own account, and costing about £7,000.

The undertaking received from the Siamese Government a concession for 50 years, under favourable conditions, and besides, entered into a contract with the King for lighting with 2,000 glow-lamps at the price of 2 ticals (3s.) per lamp monthly. In addition 500 private lamps were already installed and connected with the mains, whilst numerous other consumers were only waiting for the successful action of the works in order to be connected.

But although the Siam Electric Light Company commenced lighting Bangkok under very favourable auspices, it found itself compelled, after a short career, and before it had begun its full activity, to go into liquidation, and its entire property fixed and movable will come under the hammer, unless in the meantime a purchaser comes forward to take over the works, with the concession and the contracts, which have been already entered upon. The cause of the collapse is said to be "unpleasant technical and financial difficulties."

Hitherto two offers for the purchase have been made by a Siamese syndicate to the amount of £16,000, and by the Brush Company of £20,000. That the Brush Company seriously intend to acquire the installation, or at least to introduce order into the state of affairs, may be judged from the circumstance that Mr. Clements, the manager of the Brush Company's Temesvar works, has been staying at Bangkok for some time.

The *Siam Free Press* comments upon the subject as follows:—The Siam Electric Light Company, after much hesitation and floundering, have at last come to what appears to be a very reasonable conclusion. The plant is to be offered for sale, the company's premises are to be let on lease, or sold as the case may be, and tenders are to be invited for the taking over of the entire property of the defunct Siam Electric Light Company. This arrangement is generally admitted to be the best that could be arrived at, as it affords another opportunity to some enterprising firm to carry out a project which will undoubtedly prove a success once it is freed from Siamese management and control. The bane of any enterprise in Siam is to have native princes or nobles as directors or managers. They have little or no idea of business in the strict sense of the word, nor do we expect it of them, and can scarcely be held responsible for an ignorance which is but a necessary adjunct of their peculiar surroundings. To place such men in charge of a commercial undertaking is to court failure, and the miserable bungling of the affairs of the Siam Electric Light Company only affords another melancholy example of the incapacity of the native mind to grapple with the fine art of company management. The surprise was that European shareholders could be found ready to risk their money in a concern that was doomed to failure from the very commencement, owing to the peculiar constitution of the company and the non-responsibility of the Siamese shareholders. The present fiasco has probably opened the eyes of the most obtuse to the dangers and pitfalls attending companies and corporations under Siamese jurisdiction, and henceforth European investors will view with considerable circumspection and suspicion any enterprise under native administration and control.

That the electric lighting of Bangkok will prove a financial success in the hands of competent management we believe to be generally taken for granted. The concession of fifty year's duration which has been granted by His Majesty to any company taking over the property of the Siam Electric Light Company, the guarantee that the Palace will take 2,000 lights at two ticals (each) per month, and the very great probability that the majority, if not all, of the government offices, barracks, and public departments will ask to be supplied with the light, holds out every prospect of a successful future for any company undertaking the lighting of Bangkok. It may be reasonably supposed, if not assured, that the number of lamps required by the Palace will considerably exceed 2,000. 3,000 to 4,000 lights would probably be a more correct estimate. When we add to these the number of lights which it is fair to assume will be taken by the various departments, and the general public, it may be calculated that from 5,000 to 6,000 lamps will be in demand. From this estimate we have left out the street lighting which it is understood the Siamese authorities are willing to undertake as soon as the electric plant shall be in complete working order. From 7,000 to 8,000 lights may be taken as a not too high estimate of the demand for the electric light, and this demand will of course increase in proportion as the efficiency and value of the illuminant become more generally appreciated. With 7,000 lamps bringing in a revenue of 14,000 ticals a month, the future of the electric light in Bangkok is assured, for it is only reasonable to expect that as the city grows and business increases, the utmost capacity of the present plant will be severely tested.

With no gas in Bangkok or any prospect of any such means of illumination in the immediate future, and with kerosene oil at high prices and most unsatisfactory as a luminant we see no reason why the Siam Electric Light should not have a brilliant and prosperous career, if only taken in hand by competent and experienced Europeans.

DOES OHM'S LAW HOLD TRUE FOR ALTERNATING CURRENTS OF HIGH TENSION AND HIGH FREQUENCY.

There appears to be some doubt as to the truth of the electrician's *vade mecum*, $C = E \div R$, in connection with the modern developments of electricity with alternate currents of high potential and high frequency. We have little fear but that the law will ultimately be proved to hold good for all possible cases, and that the reason for the present doubt is to be found in an imperfect conception of the phenomena. Yet, judging from the varied opinion of experts on the subject, the matter needs ventilating, if only to remove erroneous ideas and assist the already overweighted electrical student.

The question of the validity of Ohm's law has arisen in connection with the Tesla effects. After a recent exhibition of some experiments by Mr. Simpson, of Messrs. Siemens Brothers & Co., at the Crystal Palace, the question was put pointedly, by Mr. Frank C. Perkins we presume, since he, in the New York *Electrical World*, for April 30th, and also in the American exchanges, publishes an article on the subject. The experts, however, were unwilling

to commit themselves without due thought and so the following questions were submitted in writing :

1. Do you consider that the phenomena of Mr. Tesla's experiments are due to high frequency and high frequency currents alone ?

2. Do you consider that Ohm's law holds perfectly true for alternating currents as well as for continuous currents ? and for currents of high frequency as well as low frequency ?

3. For instance: Taking the terminals of Mr. Tesla's apparatus, with a difference of potential of thousands of volts, and connecting the same with a copper wire of low resistance, or by Mr. Tesla's body, why should not enormous currents flow if $C = E \div R$? Do you consider it due to the high frequency of the current ?

4. Again, if 2,000 volts is all that is necessary to kill a man, and if the resistance remains constant, and the E.M.F. rises to enormous values, why should not the current also rise to a very high value, and produce the same result with a person in circuit ?

In answer to the above questions Mr. W. H. Preece, of the Post Office Department, London, gives the following reply :

There is no doubt that Ohm's law holds perfectly true under all circumstances whatever, but there are variations in dealing with alternating currents due to counter electromotive forces arising sometimes from electro-magnetic, and sometimes from electrolytic effects, that cause departure easily calculable. The effect on the human frame is probably due to the counter E.M.F. set up by the decomposition of the liquids of the body.

These counter effects are developing themselves in directions we least anticipated. There is no doubt that an arc behaves itself as though it had self-induction, and self-induction is a phenomenon that is very little understood and often misapplied. It is a term frequently used to hide our ignorance.

Prof. D. E. Hughes thus states his views regarding the above questions :

1. Mr. Tesla has not yet published his paper on the subject, but I believe he thought they were due to high voltage combined with high frequency, and in this, I believe he is perfectly right.

2. No. My own experiments, and, I believe, all made by other experimenters show that, with alternating currents, we have to contend with self-induction, which interferes greatly with any rapid transmission of alternating currents. In fact I can image a voltage and high frequency so great that the best conductor would be almost opaque to electrical currents, and often air and other insulators will offer less resistance than a so-called good conductor.

Prof. William Crookes says :

I certainly consider that the striking phenomena of Mr. Tesla's experiments are due to the very rapid alternations he works with. I have not experimented sufficiently with Tesla's apparatus to enable me to say how Ohm's law applies to his currents. Rubbing a cat's back or a stick of sealing wax will give a half inch spark. This is equivalent to an E.M.F. of about 10,000 volts. But you cannot manufacture current by passing the spark through a wire of, say, one ohm resistance.

Prof. W. E. Ayrton, of the City and Guilds of London Institute, states that :

To answer these questions would require one to write a paper on the theory of rapidly alternating and intermittent currents. This I cannot do at the moment, I am sorry to say, but I may shortly add, however, that the equation $C = E \div R$ certainly does not hold in such cases if by R you mean the resistance as measured with a steady current.

Mr. Gisbert Kapp, electrician to the firm Johnson and Phillips, makes the following interesting replies ;

1. As to the physiological effects: We know that strong sound waves of sufficiently low periodicity may injure the drum of the ear, yet if we increase the frequency we get at last a note of so high a pitch that it does not affect the human ear at all. Also with light; the white rays of an arc light can injure the retina; but if you only get the ultra violet rays there is no effect. I quite admit that these analogies are not very scientific, but, perhaps there is something in them.

2. Self-induction effects: It is not the voltage which kills, but the current. Now, if owing to the high frequency the back E.M.F. of self-induction becomes very high, it is quite conceivable that the choking effect of the body is sufficient to prevent the passage of more than a very few milliampères, which current can be taken without harm.

3. Skin effect: Lord Kelvin (Sir William Thomson) showed that a conductor carries alternating currents more on the skin than the interior, the effect being the more marked the larger the conductor and the higher the frequency. It is at least conceivable that the Tesla current passes principally along the very outermost layer of the skin, and thus does not affect the vital parts of the body.

Mr. James Wimshurst, inventor of the Wimshurst machine, says :

1. I was one of the many who had the pleasure of witnessing Mr. Tesla's interesting experiments, but I fail to see in them much if any more than a great expenditure of money and energy. A large part of the phenomenon may be due to statical charges having fairly high frequencies.

2. I consider Ohm's law holds true for continuous currents, but that additional influences are imparted when alternating currents are used.

3. Enormous currents are produced only by enormous energy. $C = E \div R$ for direct flow, but in Mr. Tesla's experiments either the R was unknown or the necessary E was wanting. I think he would not venture to complete the circuit, his body only being the R. High frequencies add to the R, but the frequency he used did not, I think, so materially reduce the current as to make it's quantity become less.

4. In your last question you seem to omit the influence of chemical action producing resistance, or back E.M.F.

Dr. J. A. Fleming expresses himself to the following effect :

You ask if Ohm's law is true for alternating currents of high frequency ? What is commonly called Ohm's law is true as far as it goes, but it is not the whole of the story. When you are dealing with continuous or unvarying currents, the current strength is related to the impressed electromotive force in a very simple manner as expressed by the numerical law $R = E \div C$. The moment you have to deal with alternating or varying currents we have to take into account, in addition to the mere ohmic or true resistance of the circuit, the induction or self-induction of the circuit. If the frequency becomes very considerable, the capacity of the circuit has to be considered as well; and the current strength is then related to the impressd E.M.F. by a very complicated law which involves the resistance, inductance and capacity. Moreover, when the high frequency is employed, the current in a copper wire is practically confined to the mere skin or surface of the wire. As regards the physiological effect of alternating currents of high frequency, it seems to be undoubtedly the fact that they are less injurious than currents of low frequency. The reason for this is partly physiological as well as physical. As a matter of fact, however, it is very interesting. When Mr. Tesla had his apparatus at the Royal Institution, following his example, I tried the shock from his high frequency coil and was surprised to find how slight it was. It will need much more research before your questions can be properly answered. As regards the flow of current in conductors under alternating E.M.F., you will find that explained in my treatise on "The Alternating Current Transformer," and the matter comes briefly to this: Ohm's law as an expression of a fact in continuous current flow is no use whatever as a rule for interpreting the greatly more complicated phenomena of alternating currents of high frequency.

Mr. Alexander Siemens, of the firm of Siemens Bros. and Co., says :

Ohm's law is certainly true for alternating currents as well as for continuous currents, also for high and low frequency. In your first example you overlook that it has not been proved that those enormous differences of potential really exist, and, further, that the source of electricity utilised in Mr. Tesla's experiments is not capable of producing such large currents, if these differences of potential are produced.

The following statements were made by Mr. Swinburne :

1. I do not think Mr. Tesla has discovered, or claims to have discovered, any new phenomena. His experiments are more brilliant than those performed with Rhumkorff coils or Wimshurst machines, because he has brought more modern knowledge to bear on the construction of his apparatus. The high frequency also enables him to get more brilliant effects where capacities are concerned, as, with a given E.M.F., the current into a condenser varies as the frequency.

2. I consider Ohm's law holds good at all frequencies. Of course, self-induction and capacity become more important in determining the flow in any circuit the higher the frequency ; but Ohm's law holds all the same.

3. If Mr. Tesla touched two poles whose potential continued to differ by 2,000 volts he would be killed. If the frequency were very high a copper conductor of low resistance, say one ohm, would not take 2,000 ampères for two reasons. In the first place the conductor has some self-induction, and this would cause a back E.M.F., which at a very high frequency would reduce the current considerably. In the second place the initial induction of the different parts of the current stream would produce the "skin effect," so that with a very high frequency the apparent resistance of the copper would go up enormously. This "skin effect" has been studied by Lord Kelvin (Sir William Thomson) and others, and can be calculated for any size of wire conductor if the frequency is stated.

4. The reason why Mr. Tesla was not killed is that as soon as he touched his transformer the pressure ceased. It is the same as touching a small Wimshurst machine. It can give many thousands of volts, but only on open circuit.

If an ordinary transformer is tested carefully it will be found that at full load the fall of pressure is too great to be accounted for by the resistance of the windings. The extra drop is due to magnetic leakage. This drop depends on the form of the transformer and on the frequency. By utilising this phenomenon, Prof. Elihu Thomson produced constant current transformers. In a transformer of the design used by Mr. Tesla the drop at the high frequency employed was so great that the instrument was incapable of giving any appreciable current.

Here follow the opinions of Prof. Silvanus P. Thompson, F.R.S.

1. Tesla's experiments so far as they relate to production of illumination in vacuum tubes that are disconnected or only connected by one electrode are due to effects of high voltage than to high frequency. It has been known for years that such effects could be produced on a

smaller scale by the discharges of ordinary induction coils, with low frequency breaks, but of high voltage. Tesla has shown them on a larger scale, and, by using high frequency as well as high voltage, has made the effects not only much more brilliant but much more continuous. It must, however, be borne in mind that high voltage and high frequency are in many cases bound up in one another. If you drive an alternator at a higher speed, both volts and alternations go up.

2. Do I consider that Ohm's law holds true for alternating currents? This is not a matter of my opinion or any one else's opinion; it is a question of fact. You might as well ask an engineer whether in his opinion the law of expansion of heat was true for liquids. It is not a matter of opinion at all. Ohm's law is certainly not true for alternating currents unless you take into account all the electromotive forces—those due to mutual and self-induction as well as that impressed on the circuit by the alternator. (See p. 629 of the fourth edition of my "Dynamo-Electric Machinery," 1892.) If you take all the electromotive forces into account and apply Ohm's law, then your calculations will accurately represent the facts. But if you leave out of sight these other electromotive forces and suppose that the E.M.F. of the alternator is the only one present, then it will be found that the calculation does not fit the facts.

3. This reply answers the third question, whether the law applies also to high frequency currents. Certainly it does, if (and the IF is a big one) you apply in the calculation all the other electromotive forces of reaction that actually arise in the case. Ohm's law is only after all a statement of the proportionality which exists (and must exist) between an effect (the electric current) and its cause (the electromotive force). If you in your calculation leave out part of the cause the calculation of the effect will be wrong.

4. You ask why enormous currents should not flow through Mr. Tesla's body when he touches the two terminals, which a moment before were at a difference of potential of thousands of volts? Please remember here, that in Tesla's apparatus—with an induction coil that has its secondary wires and its primary wires not in close geometrical relation, and not wound upon a common iron core forming a closed magnetic circuit—there is very great self-induction, and this, at high frequency will produce a great reaction, precisely as self-induction does in the so-called constant current alternating current apparatus of Stanley. The result is that there will be a tendency to the production of a constant (small) value of alternating current—perhaps about $\frac{1}{1000}$th ampère—and certainly not a tendency to keep the volts constant. In this case Ohm's law should be used the other way round: E = C R. When there is nothing across the terminals, R is enormous—so is E. When you join the terminals with the hands or with a copper wire, R is small, and E therefore becomes small also.

5. Lastly, you ask why the current does not rise to very high values when the volts rise to high values? This is a simple result of the reaction due to self-induction. When the current rises, even a very little, it sets up reactions of an electro-magnetic nature which produce counter electromotive forces, and therefore the volts literally are not so high. I doubt if the volts from one of Mr. Tesla's hands to the other, while he was touching the terminals, were as much as 200 volts; the current through his body, small though it was, damped down the volts. Remember, that at high frequencies every inch of straight wire will act as a "choking coil," and may produce relatively as great an effect as Elihu Thomson's choking coils do in his low frequency currents, which he uses for electric welding.

From the preceding extract of some of the answers to the questions put, we may rest assured that Ohm's law does hold true, and that we only need to more thoroughly grasp the effects of high frequency currents on circuits of large self-induction, though small Ohmic resistance, to understand much that is now inexplicable. The physiological effects of high frequency currents are certainly most peculiar, but then there seems to be a reasonable doubt as to the value of the voltage when the circuit is closed, and at any rate the horse-power in Tesla's experiments was very small.

RELATIVE WEIGHTS AND COST OF DYNAMOS.

By ALBION T. SNELL.

Probably most makers of dynamos and motors are, from time to time, in the habit of plotting curves, connecting the weights, outputs, and cost of machines. I have done this myself yearly, as the necessity for a new price list has arisen, and have by this means been able to check not only my own figures but also to compare them with those of my competitors. Having plotted such curves from the price lists of some eight or ten of the best known makers, one will be surprised, perhaps, at the large variation of cost for given outputs; and moreover, the curves are not parallel, but cut each other at various points without following any apparently definite law.

These vagaries are the results of very simple causes. Firstly, the cost of production of a given size of machine is very largely dependent on the number that can be made simultaneously and this, of course, is regulated by the sale for such size. It may happen, therefore, that a firm can turn out a few particular sizes more cheaply than they can others, and hence if the list price be rigidly determined by a fixed rate of profit on the cost of production, there will be a departure from symmetry in the curves. Secondly, the type of machine has a good deal to do with the law governing the cost of production, and different slopes will be obtained for the "price-output" characteristics, if I may use the phrase, of the several types. For instance, it is now generally recognised that the cast iron single circuit magnet two-pole field is the cheapest form for medium size machines, say, from 2 to 30 kilowatts. Below or above these limits, I have doubts whether wrought iron magnets would not be cheaper; and probably for larger machines, even a double magnetic circuit would save money.

There is a third reason for discrepancies in price lists which, no doubt explains much that is otherwise puzzling, this is the voluntary or involuntary adhesion to an old type of machine which, though at one time, perhaps the best in the market, has long since been distanced by more modern designs. It would be invidious to mention names, but two or three instances rise to my recollection. I am inclined to view favourably the anomaly and assume that patent rights and other considerations of a similar character debar the "scrapping" of the whole. There is just one thing to be said in favour of retaining types obsolete as regards modern views, and that is, their production has been reduced to a science, special tools, jigs and templates are always used, and a change would entail no little trouble, besides doing away with so much plant.

Another, and little recognised cause, lies in the method of varying the sizes for different outputs. The determining factor of the machine is the armature, and to economise materials, tools and patterns, certain definite diameters of plates are pre-arranged, say 10 inches, 12 inches, 15 inches, 18 inches, 24 inches, and so on. If it were convenient to build machines with armatures all having a given ratio of diameter to length, the curves would follow symmetrical laws; but it is obviously impossible to do this and yet conform to the varied requirements of practice. So each diameter of armature is made in two or three lengths, and the machines are listed as 12/12, 12/16, &c. One firm I know, makes three lengths for each diameter; another finds it convenient to make four with the smaller sizes, three with the medium, and two with the larger. Now note the curious result that creeps in through this custom. The outputs of a short and a long 12-inch armature (say 12/10 and 12/16) may be made, by suitable adjustment of speed, to follow a straight line law; but for the same speed the longer armature machine will give the larger output per pound of total weight, and will be proportionately less costly to build. And the change of diameter of armature may vary the weight-output efficiency even more than the preceding consideration. For since the ratio of output to weight increases with the length of the armature, and the long 12 inches precedes a short 15 inches, there will be two machines close together in the series, the one having a maximum and the other a minimum weight-output efficiency. Theoretically, if the diameter varied with the output, and the length had a constant ratio to the diameter, the speed of rotation would be based on a fixed surface velocity; and the weight would vary directly as the output; but in practice, owing to the question of the cost of production, this method cannot be adopted. And since purchasers judge the speed by the number of revolutions and not by the surface velocity ($\pi d n$, where d = diameter and n = revolutions) armatures of the same diameter will usually be listed at or about the same speed, and a large variation in weight-output efficiency may be introduced just at the point of the curve referring to a change of diameter of armature. These various reasons, then, show why prices differ so widely and the ratio of weight to output is so varied, and we see from these simple considerations that the curves obtained from various makers' price lists must necessarily differ more or less. But there is a tendency to a closer approximation in prices owing to competition; and the most favourably placed makers, whether from design of machine, increased facilities for buying material, or means of procuring cheap labour, derive larger profits than those less fortunately situated.

Mr. Carl Hering, in the *Electrical World*, of New York, for April 30th, gives an interesting article on this subject, and although the American selling prices cannot be usefully compared with those obtaining here, yet the slope of the curves and the points of departure from symmetry may be studied with advantage. The weight-output characteristics can, of course, be compared with any make of machine. Mr. Hering says the curves refer to the "list" information of two prominent manufacturers in the United States. But unfortunately he only says the machines are of the two pole incandescence type, and gives neither the shape of magnets, the kind of armature, nor the surface velocities, hence the value of the curves is very much lessened, as will be apparent from the preceding remarks. Fig. 1 shows in a very clear way how curiously such curves

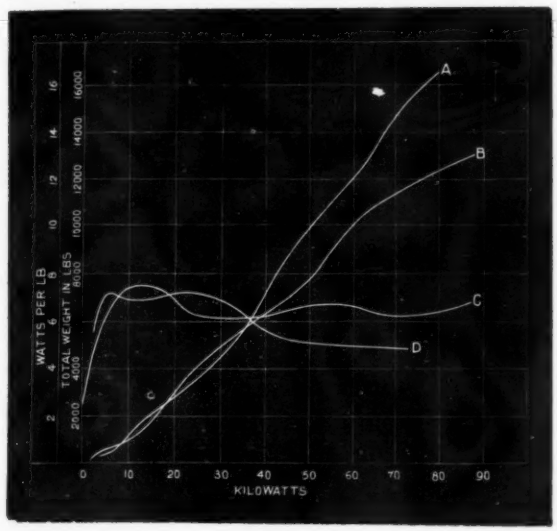


FIG. 1.

tend to cross and even re-cross each other; and their final divergence for heavy outputs is probably caused by the one type of machine being the better suited for large powers. Curves A and D refer to the one set of machines; and curves B and C to the other set. A few useful deductions can be made at sight. A and B show the relation of weight to output in kilowatts, and since they are both nearly straight the outputs increase practically in direct proportion to the weight, and therefore approximately with the volumes or cubes of the linear dimensions. This is an interesting point and shows the opinion now generally held by experienced men to be fairly correct.

Curves C and D give the watts per pound obtained in the different sizes of the machines. They are very irregular, particularly with the smaller outputs. Probably variable peripheral velocities as well as alterations in diameter of the armatures account largely for this. But the general direction of C is straight after an output of about 25 kilowatts, while D shows a decided tendency to fall after the same point is passed. C shows that for machines of more than 10 kilowatts, about 7 watts per pound is a fair average for a wide range of output. In D the output through the same range varies between 7 and 5 watts per pound. This watts-per-pound curve does not give very satisfactory comparative data, since it is taken from a price list, and one maker may allow a margin or factor of safety, whilst another may list the maximum safe output as determined by actual trial.

Comparing the set of machines referred to in A and D with that of B and C, I am inclined to think the former the better designed, judging from the greater regularity. Up to 35 kilowatts there is not much difference between the "weight-output characteristics," but beyond this there appears to be an increasing divergence. From this I should guess the A set to have massive double circuit magnets and slow speed gramme armatures; while probably the B set has single magnets of lighter type.

Fig. 2 shows the relation of the list selling price and output. In A and B the total selling price is plotted against the output in kilowatts, whilst in D and C the variation in selling price per kilowatt and total output is shown. On inspection we see that the total price is nearly proportional to the output. This is to be expected, although the ratio of value between labour and material for different sizes has wide limits. The chief point of practical import is the very rapid increase in the cost per kilowatt for small machines. This is a fact now well recognised in England, and few manufacturers care to build dynamos or

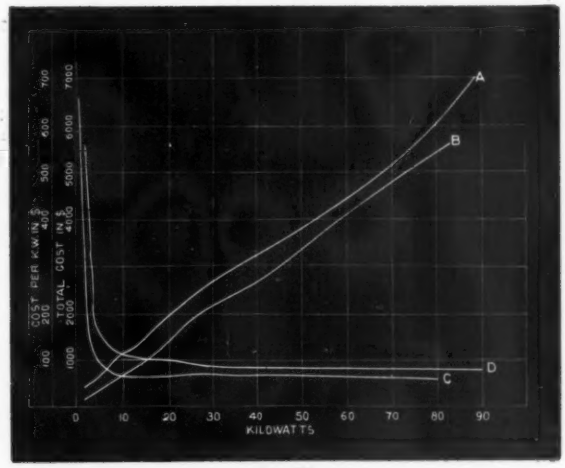


FIG. 2.

motors of less than two horse-power; and even for this size the profit is very small, unless the number turned out be very considerable.

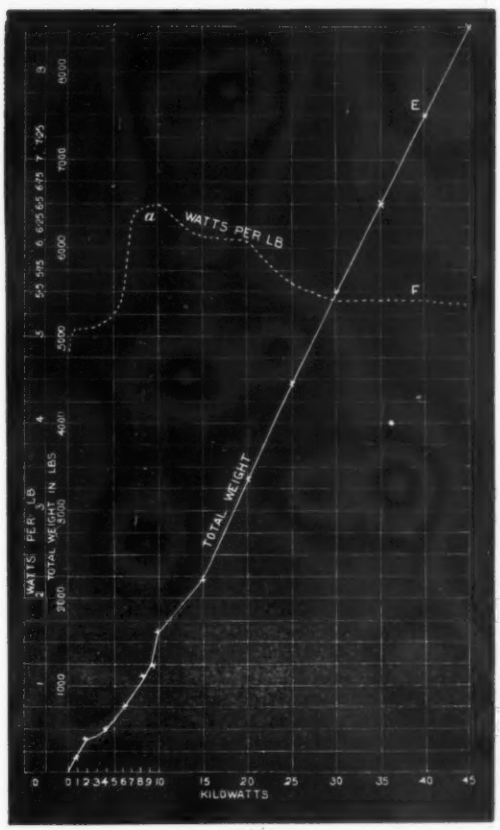


FIG. 3.

In order to show how these curves compare with those obtained from machines of English manufacture, I have plotted from the list of a well-known firm of dynamo and motor builders four curves. The type of machine referred

to is bi-polar, has a massive wrought iron double magnetic circuit, with cast iron pole pieces, and slow speed gramme armatures, and is suitable for tensions varying between 100 and 500 volts.

In fig. 3, curve E shows the relation between weight and output, and F similarly gives the connection between the watts per pound, and the output of the machine, E is practically a straight line, and clearly shows that the output is proportional to weight. The rise at *a* in curve F is caused partly by the surface velocity of the machines at this point being higher than that of the other sizes, and partly by the particular proportions of field and armature found expedient. The factor of safety allowed in the machines in question is high, and so the number of watts per pound appears to be low; but really the output can be raised to 7 watts per pound by simply increasing the speed, without undue heating or abnormally high speed.

In fig. 4 which shows the connection between cost and

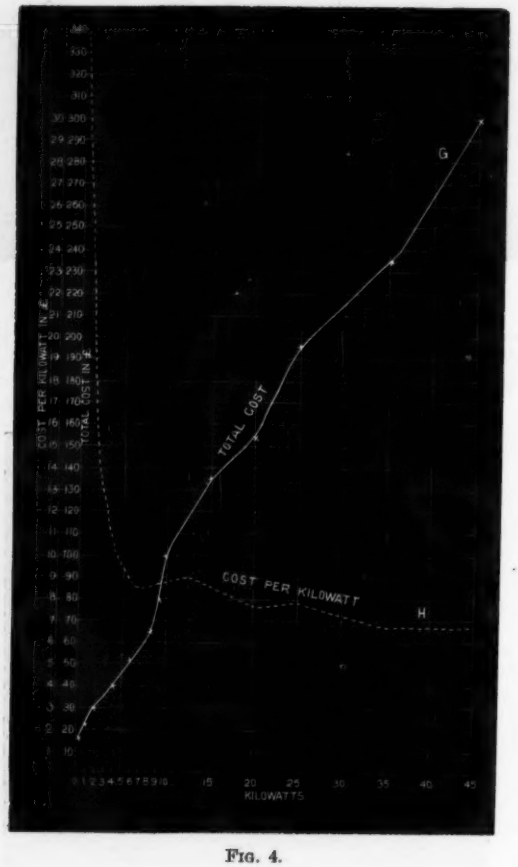


FIG. 4.

output, curve G, indicates how the total cost varies with the output; and since it is practically a straight line the cost is directly proportional to output. In H we see the relation between the cost per kilowatt and the total output of the machine. At 35 units the price is about £6·75 per kilowatt, and this appears to be maintained up to the limits of the list, 45,000 watts. The costliness per kilowatt of small machines is well marked, and the smallness of the possible profit may be inferred. It must be borne in mind that these prices are subject to a discount. There is not much to be gained by making a quantitative comparison between figs. 2 and 4, but a qualitative one is instructive. It will be noted that there is a striking similarity in the shapes of the three sets of curves; and that in each case the bend on the cost-per-kilowatt curves occurs at about a 5-unit machine. This tells us that dynamos of less than this capacity are costly to build, and, further, the price per kilowatt will increase rapidly as the output be diminished.

The subject is worthy of study, and the experiences of different makers would be interesting as well as instructive.

DINNER AND TESTIMONIAL TO PROFESSOR AYRTON.

A COMPLIMENTARY dinner was given to Professor W. E. Ayrton, F.R.S., on Friday last, at the Holborn Restaurant, by 21 of his former students who have since attained some fame in the electrical profession. Among the guests were Mr. W. H. Preece, F.R.S., Dr. Silvanus Thompson, F.R.S., Professor J. Perry, F.R.S., Mr. F. H. Webb and Mr. James Swinburne. Mr. W. B. Esson occupied the chair, and after the usual loyal toasts had been honoured, Mr. A. T. Snell proposed "The Colleges of the City and Guilds of London Institute," coupling with this toast the names of Profs. Thompson and Perry, both of whom responded in most felicitous terms. Prof. Thompson regarded it as a privilege to carry on the work at the Finsbury College which was so well begun by Prof. Ayrton, while Prof. Perry, in his humorous speech, claimed to be as much an old student of Prof. Ayrton as any one of the subscribers present, inasmuch as he had been a deal of trouble to Prof. Ayrton and had been well instructed and well bullied by him into the bargain.

The Chairman, in proposing the toast of the evening, observed that in their student days many of the old students had been "toasted" by the professor in a somewhat different way; now, the position was reversed, as they were in turn toasting Prof. Ayrton. After referring to the progress made in recent years both in electric lighting and the electric transmission of power, the chairman said that all along the plane of development in both branches could be traced the name of Ayrton, and he emphasised the fact that amid the many valuable contributions to electrical engineering, his researches in the domain of physics had not been less important or less appreciated. This had been recognised by his being elected as a Fellow of the Royal Society and as President of the Physical Society. But Prof. Ayrton was also President of the Institution of Electrical Engineers, and through this position he combined the qualities of the theoretical physicist with those of the practical engineer, and this was the main secret of his success as a teacher of technology; while professors of academic seats of learning might believe that the function of a university was to teach useless knowledge, Prof. Ayrton believed that the function of the technical colleges was to teach that knowledge which might best enable a man to carve his way in the world. Past students did not wish Prof. Ayrton to forget all about this pleasant dinner party, so they had put the expressions of their esteem in a more permanent form. The chairman then handed to Prof. Ayrton an illuminated testimonial framed in gilt oak and bearing the names of Messrs. L. B. Atkinson, Frank Bailey, H. J. Dowsing, W. B. Esson, W. Geipel, R. J. Jones, W. M. Mordey, I. Probert, A. Reckenzaun, F. M. Rogers, H. M. Sayers, W. B. Sayers, R. P. Sellon, A. T. Snell, W. E. Sumpner, E. B. Vignoles, R. M. Walmsley, H. D. Wilkinson, and Arthur Wright. The health of Prof. Ayrton was then drank with enthusiasm.

In responding to this toast Prof. Ayrton said he felt deeply grateful for the very kind and appreciative way in which his labours had been referred to, and thanked them most sincerely for the testimonial they had kindly presented to him. He dwelt upon the rapid advance in recent years in popular views on technical education, an advance our forefathers never dreamed of. The London County Council voted £30,000 per annum for the teaching of science to industry, but there was something like a million pounds sterling available, if a band of idealists were to come forward and endeavour to secure even a portion of this princely income. Prof. Ayrton suggested the establishment of a great laboratory of physical research, where all who entered would be students in the highest sense of the word. There would be no examinations, but all would work for the general advancement of knowledge for the good of the community. In conclusion he alluded in praiseworthy terms to his assistant and associate Mr. Mather, whom he designated a veritable hero in science. Mr. Atkinson proposed the toast of "The Institution of Electrical Engineers," to which Mr. F. H. Webb, the secretary, replied in very appropriate terms. The health of "Our Guests," proposed by Mr. R. P. Sellon, was responded to by Mr. W. H. Preece in his light and airy vein. Between the speeches some excellent vocal and instrumental music was enjoyed, the artists being Mr. Trefelyn David, Mr. Jacobi, and Mr. Emerson.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS AND TRANSFORMERS.

BY RANKIN KENNEDY.

(*Continued from page* 569.)

THE synchronous alternating current electromotor is undoubtedly the most economical and perfect motor for alternating current work. An efficiency of over 90 per cent. can easily be attained by these motors; their self governing at constant speed is perfect within the limits of their maximum power. There is the difficulty of starting them up to the synchronising speed. There are three methods for starting them, but none of them enable the motor to start with any load on; that, however, is not always a drawback.

The first method we notice is that used by Mordey, starting the motor by energising a continuous current exciter on the shaft of the motor by a continuous current, thus operating the exciter as a motor until the speed rises to that of synchronism.

The second, used by the Westinghouse people, starting the synchronous motor by a small Tesla motor, and running it up to synchronous speed. The Tesla motor is driven by the alternating current, being split into two branches arranged to produce the difference of phases required to work the Tesla motor.

The third method is that in which a commutator is required to start the motor; this method has been mentioned by Prof. Geo. Forbes in his late lectures, but no detailed description has been given of the arrangement. The author some years ago practically investigated this subject and proved that this method when applied in certain alternators was in every respect the best method for starting up synchronous motors.

Every dynamo alternator cannot be started up as a motor by the commutator method, the alternators to which this method is applicable, with successful results, belong to that class in which there is no reversal of magnetic induction through the armature coils, and in which the E.M.F. is due to the coils passing from a position of maximum induction to a position of minimum induction and *vice versâ*. In these machines there are twice as many armature coils as there are magnetic fields in the machine; machines of this class are common enough. The author's ironclad dynamo alternator belongs to this class, and so does the Mordey alternator, as made by the Brush Company.

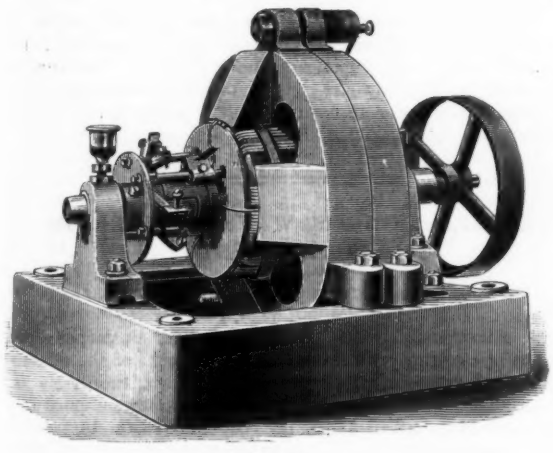


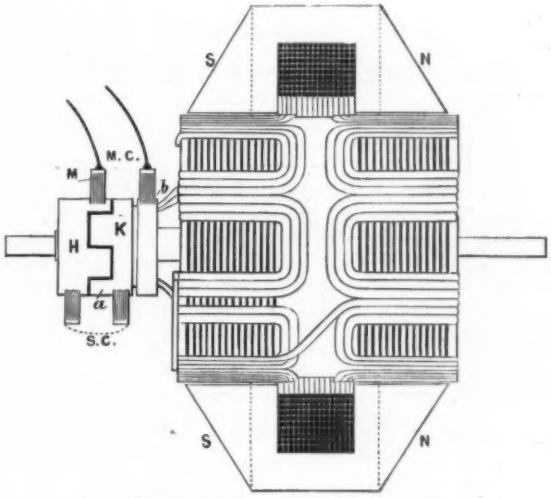
FIG. 5.

Machines in which the magnetic induction through the armature coils is alternately in opposite directions do not succeed so well in starting up with the commutator method, the reason being that when wound with two series of coils on the armature, as explained in last article with reference to a Kapp alternator, the currents or counter E.M.F. are in the two series of armature coils in quadrature phase, and therefore only one of them can synchronise with the single alternating current synchronous speed has been attained; this distinction when between the two classes of machines is of importance and has not hitherto been pointed out. Machines of the first class, having no reversals of magnetic induction, make excellent motors for starting up to synchronism with a commutator; machines of the second class do not start with a commutator, but can be used successfully as two-phase motors self-starting without a commutator when supplied with two alternating currents in quadrature phase.

Fig. 5 shows a synchronising motor successfully applied by the author and made self-starting by a commutator, this commutator is used only for starting the motor up to synchronism. When that speed is attained the commutator is cut out by a switch.

Small machines are excited by a shunt circuit, in which the alternating current is rectified by the same commutator used for starting.

Large machines have a separate exciter mounted on the shaft of the motor, as is now the practice with large alternators.



M C, Main current; S C, Starting commutator.

FIG. 6.

Fig. 6 is a cross section of the motor, showing two armatures, a, a', and one ironclad field magnet, S N, N S, with one exciting coil, c. The armature coils are flat hanks laid on the armatures and are double the number of poles. As shown

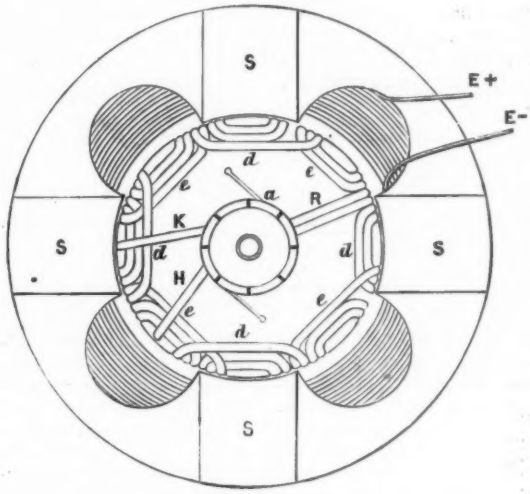


FIG. 7.

in fig. 7. They are coupled up in two series, the coils, d, d, d, d, forming one series, the coils, e, e, e, e, forming another series; the coils of the one series alternating between the coils of the other series. The two series of coils are joined together and their junction to a ring insulated on the shaft. See R, fig. 7, and b, fig 6.

The one end of one series is connected to one half of the commutator, K, and the end of the other series is joined to the other half of the commutator, H, figs. 7 and 6.

To start this motor the main current enters, as shown in fig. 6, by two brushes; the brush on the toothed portion of the commutator admits and cuts off the current from the series of armature coils. In the position shown in fig. 7 the current would be just cut off from coils, *d*, *d*, *d*, *d*, and admitted to coils, *e*, *e*, *e*, *e*, thus producing a torque which raises the speed to synchronism. When this speed is attained the brushes at A, fig. 6, are joined by a switch to the brush, M, fig. 6: thus making the commutator act only as a simple ring contact after synchronous speed is reached.

This method of starting synchronous alternating dynamos is simpler and cheaper in first cost than any of the other methods. It can be applied to other alternators of the same type as that herein illustrated, by connecting the two sets of coils to the commutator, as shown.

(To be continued.)

DIFFICULTIES OF AN ELECTRIC TRAM LINE.

[FROM OUR OWN CORRESPONDENT.]

During the Industrial Exhibition of North-Western Germany, held at Bremen during the summer of 1890, an electric tram line was installed. The line acted very satisfactorily. It extended from the Exchange to the Exhibition Square, *i.e.*, 1·6 kilometre. The Bremen Tramway Company resolved soon afterwards to fit up one of their longest lines for electric working, *i.e.*, from the Exchange to the Horn terminus. The Thomson-Houston system of overhead wires and trolleys is used. This overhead wire is held in its place by other wires fastened to posts and houses. The return wire lies on the ground between the rails. On May 8th the line was opened for public traffic after all manner of difficulties had been encountered. Some weeks ago, in a trial trip, the copper wire broke and fell upon some telephone wires. The telephones in connection with these wires were burnt. More wires were then attached, so that the copper wire, even if broken, cannot fall to the ground. Last week there occurred a new accident. The fire brigade (on what pretext it is not said) laid a telephone wire over the electric line, the wire broke and fell upon the tramway wire. The fireman holding one end of the telephone wire was knocked down, but quickly recovered himself, several telephones, however, took fire. More protecting wires were then attached, and a varnished wood casing was laid above the copper wire, so that it cannot come in contact with other wires. The fire brigade now complain that the network of wires in narrow streets form a serious hindrance in case of fire.

PROJECT OF AN ELECTRICAL TRAMWAY BETWEEN ST. MORITZDORF AND ST. MORITZBAD.

[FROM OUR OWN CORRESPONDENT.]

The two Swiss watering places, St. Moritzdorf and St. Moritzbad, each of which has recently erected for itself independent electric works, are about, it is said, to be connected by an electric tramway. For this purpose, there has been formed an initiative committee, which has invited a competition for the construction of the line. Although the question whether the line is to be worked electrically or pneumatically has been left open, or left to the option of parties tendering, it may be assumed as certain that electricity will come into use as the motive power.

For the preparation of tenders for this project the following general regulations have been drawn up, from which no essential departure can be permitted :—

1. The termini of the line are the post office square at St. Moritzdorf, and, on the other hand, the squares as near as possible to the pump hall at St. Moritzbad. The line from the village to a point about 70 metres from the bridge over the Inn must utilise as nearly as possible the existing new Badstrasse. Where possible, it must be widened by at least 3 metres, and this widening must be effected where it will occasion the least outlay, and, at the same time, where it will reduce the existing curves as far as possible, *i.e.*, it must be effected sometimes towards the lake and sometimes towards the mountain. On the side next to the lake must be laid down a causeway 2 metres in width, alongside of which runs the line with a 1 metre gauge. This arrangement is adopted so that anyone can conveniently step from the causeway into the cars without treading on the permanent way. The existing system of hydrants must be laid neither underneath the causeway nor under the body of the line, and must therefore be relaid almost for its entire l ngth.

Alongside the existing iron bridge over the Inn must be erected a second, sufficiently wide for the line and the causeway, and able to bear at least a weight of 20 tons. The present bridge must probably be removed higher up stream, for its entire width and the new tramway bridge must be erected in its present place. The piers of the bridge must be placed beneath the tram line.

At the curve of the road towards the chalybeate bath the tram line leaves the new Badstrasse, turns towards the chalybeate bath, and arrives, according to the calculation of the projectors, either first at the pump room of the chalybeate bath, and then to the Paracelsus spring, or inversely.

2. The departure of the cars are to be assumed provisionally as at intervals of 10 minutes. Two points are to be provided.

3. Besides the plans for the supports and foundations, descriptions, and if needful, plans must be worked out for the superstructure, and for the proposed system of working, whether electric or pneumatic.

Attention is especially called to the fact that a spare water power of about 100 H.P. may be open for use. At present there exists already an electric light installation, which may be used by day for working the tramway. Two vertical turbines, jointly of 500 H.P., actuate continuous current machines and an alternating current machine, with a total useful effect of 200,000 watts. It must be remembered that whilst light is being supplied, these machines cannot be used for any other purpose. The situation of the turbines for the electric lighting is about at the distance of 1,300 metres from the terminus in the post-office square.

For the present it is proposed to run the tramcars only during the summer.

Parties desirous of tendering will be furnished with plans on the scale of $\frac{1}{1000}$.

4. The initiatory committee offers for the best project a premium of 500 francs, and 300 francs for the next, the plans becoming the property of the committee. As regards the execution of the works, the committee reserves all rights to itself, though the author of the best project will, in this matter, be duly considered.

UTILISATION OF WATER POWER IN SWITZERLAND.

[FROM OUR OWN CORRESPONDENT.]

The utilisation of water power for industrial purposes by means of electricity, an important achievement of the present day, is of extraordinary significance for the industries of Switzerland, a country placed in an unfavourable position, and in consequence of its lack of coal called upon to make a more complete use of its abundant water power.

Hitherto a practical outset in this direction has been made only at a few places in Switzerland. An extensive undertaking, which is only in its initial stage, is being made at the falls of the Aar at Wynau, and when completed will be of the greatest importance for an extensive district. Herr Bangerten, of Zangenthal, has studied the question closely, and has given in, to an assembly of parties interested, a thorough-going report on the execution of such an undertaking.

Herr Bangerten shows that in Switzerland in the year 1891 there were altogether 2,359 mechanical establishments with a motive power of 54,243 H.P. water, 27,432 steam, 394 gas, and 332 electricity, or a total of 82,393 H.P., not including

the thousands of horse-power which do not come under the Factory Act. Two-thirds, therefore, of the power are furnished by water and one-third by steam, for producing which 28 million francs are sent abroad for coal and 8 millions for petroleum. But according to the calculations of the engineer, Lautenburg, of Berne, Switzerland has at its disposal more than 600,000 H.P. of water power at present unemployed and easily available.

The territory of the Wynau water power, a concession of which has been granted by the governments of Berne and Solothurn to Herr Müller-Landsmann of Lotzwylly, extends for a length of 8,000 metres with a general fall of 9 metres. A weir is to be erected above Wynau, from which a canal 1,000 metres long branches off on the right bank of the Aar, at the lower end of which the turbines will be placed.

From the weir to the turbines there will be a fall of 2·20 metres, which can be increased to 2·70 metres by damming up the water at the sluices. The total average afflux of water is at least 75 cubic metres. The fall and the quantity of water yield, therefore, at least 2,500 H.P., which may be increased to 7,000 by a suitable prolongation of the canal. The circle of parties interested, taking Wynau as a central point, has a radius of about 20 kilometres. The yearly cost of a H.P. will be from 160 to 190 francs. The concessionary, with certain reservations, has sold the whole to the Swiss Compressed Air and Electricity Company. The total outlay for erecting the works and bringing them into action will be from 2 to 2½ million francs. It is calculated that, *e.g.*, the chisel of a stonemason aided by compressed air will perform six times the work of a chisel used by hand alone.

THE PRACTICAL LIMITS OF HIGH POTENTIAL FOR THE TRANSMISSION OF POWER.*

THE experience gained during the last few years with high-tension alternate currents have raised hopes of the possibility of transmitting large powers through considerable distances, and revived the chimerical idea of one day transmitting any quantity of power to any distance with wires as small as we please, the only necessary condition being a sufficiently high initial potential. What is the practical limit for the transmission of energy at high potential as determined by our actual experience? Such is the question now before us, and answering this, we have to foretell the practice of the future, a very hazardous thing to attempt. Prof. Elihu Thomson has given some figures on the subject, and they appear to us sufficiently interesting for reproduction, with some notes and necessary reservations. Prof. Thomson considers that the transmission of large powers through long distances will be accomplished by alternating currents and concentric cables insulated with oil.

By choosing suitable frequency, current, dimension of cables, and quality of insulating oil, it is possible to balance the effects of the self-induction and the capacity of the line, and to obtain at the far end an alternate current in phase with the electromotive force which drives it. A layer of good insulating oil, 25 millimetres thick, between two rounded metallic surfaces, offers as great a resistance to sparking as a layer of air 75 centimetres deep. The experiments of Prof. Thomson show, from the sparking point of view, that a good heavy paraffin oil has a resistance of from 35 to 40 times that of air. So that he estimates a spark in air 75 centimetres long is due to a potential of not less than 500,000 volts; and his experience shows that such a potential can be controlled in an oil bath. It is impossible to say whether the condenser effects in a long line will introduce serious difficulties in practice, but if the surface of each conductor be covered with oil insulation 5 centimetres deep, a potential of 500,000 volts is possible. Using a double cable capable of carrying 200 ampères, each conductor having a section of 50 square millimetres, we could transmit 100,000 kilowatts to a distance of 240 miles, with a loss of 50,000 volts, or 10 per cent.

Such are the limiting figures indicated by Prof. Thomson. He expressly adds that it may never be necessary to deal with such large powers or long distances in practice; but that the difficulties of realisation are far less than appear at first sight, and he concludes thus:—

"The condenser action of the line is the only serious difficulty before us. Considering the danger to life, a double line insulated with oil will be less dangerous than an overhead line of much lower pressure. Any interference with the line is difficult, on account of the pipe enclosing it, and on the first weakening of the insulation, or before a leak in the pipe became complete, a short circuit of a moderate current would take place, and the fuses be blown at the ends of the line. Pipe lines are laid for the conveyance of oil; why should they not be laid for the conveyance of electric energy where it can be done economically? Looked at from the standpoint of very high potentials, Niagara may be said to be gradually approaching the surrounding cities."

But to practically realise this, it would be necessary, without joking, *to live in oil*. Since we happen to have air as the dielectric, we ought to keep to more modest potentials, whose real effect is still actually quite unknown to us. In fact, in his most recent experiments, Prof. Elihu Thomson has obtained in air, a spark 31 inches long, and he estimates this to correspond to a potential of 500,000 volts. In a letter addressed to the *Electrical Engineer*, of New York, Mr. R. B. Owens, of the University of Abraska, remarks that there appeared to be a grave error in this estimate. The experience of M. Mascart, and that of other experimenters, on the disruptive discharge as a function of the distance, show that it is impossible to get such high potentials in air, under the ordinary conditions of temperature and pressure, no matter what the distance between the electrodes may be. When less than two centimetres, the distance corresponding to a spark between two balls of 22 millimetres diameter is, according to M. Mascart, sensibly proportional to the difference of potential, but beyond this, the difference of potential increases more slowly than the distance. At 10 centimetres it is 119,000 volts, and for a gap of 15 centimetres it is only 127,800 volts, and has only increased in the ratio of 7 : 100. Constructing a curve from the results obtained, we see that the limit of the disruptive discharge in air tends towards a point which is probably not more than 150,000 volts, and that this can be as well attained between some centimetres as between many kilometres. If this curve be correct, and the facts already known lead us to assume it to be so, it would appear that the potential used by Prof. Thomson in his experiments did not exceed more than a third of that which he indicates.

In the face of present experience with sparking distances, it is evidently absurd to talk about transmitting electric energy with potentials of from 2,000,000 to 3,000,000 volts, using naked wires suspended in air; for such potentials would be perhaps capable, according to Mr. Owens, of sparking around the world. But it will be possible to use much higher potentials if we have recourse to dielectrics of higher resistance to disrupture than air.

It is, however, by no means certain that oil insulation possesses all the qualities which have been somewhat prematurely attributed to it. Prof. Thomson himself, during the further development of his experiments, has been led to modify his views relative to the qualities of oil as an insulator.

Studying the influence of the shape of the electrode and the rate of frequency on the disruptive power in oil, some recent results appear to indicate that oil, such as that which is employed for high potentials and high frequencies, offers a much lower disruptive resistance to alternating currents of ordinary periods, such as from 100 to 150 per second. At these frequencies the oil is pierced by the discharge, through even long distances between the electrodes. In certain cases, this distance is comparable to that obtaining in air for the same conditions. High frequency currents, from 2,000 to 3,000 periods per second, give also peculiar results, but the trials are not yet completed.

It appears then that the question of the value of oil as an insulator is not yet completely settled, and that there is room for fresh researches before using it commercially. It seems to be established also that potentials of from 40,000 to 50,000 volts are the extreme limits which are to-day possible for transmitting power. Beyond these figures we come into the region of fancy and paper schemes, impossible in the light of known facts.

* Abridged translation from an article in *L'Industrie Electrique*, by E. H., entitled "Sur la Limite Pratique des Hauts Potentiels Appliqués au Transport de l'Energie Electrique."

HIGH POTENTIAL PHENOMENA.

THE Westinghouse Electric and Manufacturing Company, have made a series of tests and experiments to determine the characteristics and insulating properties of certain materials when subjected to high potential influences at high frequencies. The tension was regulated by placing transformers in series, the E.M.F. on the low potential circuit being read on a Cardew voltmeter, and the high potential estimated from the ratio of conversion. This arrangement only admits of rough comparative experiments, and pretends to no scientific accuracy, but some of the results are interesting, and we reprint from the *Electrical World*, of New York, a few of the more important.

The experiments tend to show that the striking distance in air depends upon a variety of conditions, a change in any one of which will alter the striking distance for the same E.M.F., as read by the Cardew voltmeter. The most important of these appears to be slight inequalities or burning of points or surfaces used, dust on them, length of time of application of E.M.F., change in capacity of conductors or electrodes sufficient to bring in condenser effects (the latter may cause a spark across the air gap, which will be maintained), and the shape of the E.M.F. curves. It is also clear that the striking distance and the power to break down insulation depend upon the maximum E.M.F. reached, and not upon the mean as read by a Cardew voltmeter. The number of alternations per second must also largely affect this. Unexpected results sometimes happen, but these may probably be explained by the phase of the potential curve at the moment of closing the switch. With an armature giving some 266 periods per second, and very nearly a sine curve, the following effects were obtained in air, all the potential readings were made by a Cardew voltmeter, and hence have mean and not maximum values.

Kind of electrodes used.	E.M.F.	Distance in 32nds of an inch.
Two ⅜-inch polished brass balls	35,600	... 27
Two 2-inch brass plates, rounded edges ...	36,000	... 60
Two ⅜-inch brass rods turned to 90 degrees points, points slightly rounded	35,300	... 77
Ball and plate	35,500	... 48
Point and plate	36,000	... 77
Ball and point	35,200	... 63
Two $\frac{1}{10}$-inch platinum balls	35,000	... 53
Two pin points	35,000	... 66

Fig. 1 shows the striking distance in melted paraffin at 57° C., with two 90° points used as electrodes. Here again

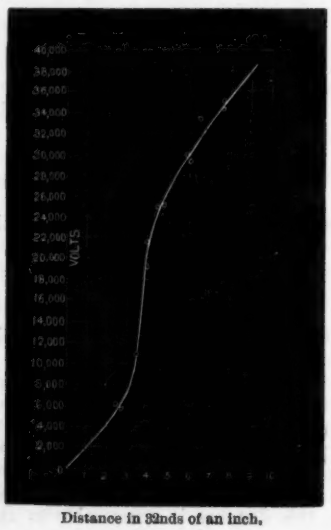


FIG. 1.

the results were affected considerably by the condition of the paraffin, and a little dirt or impurity, upset all calculation.

Some instructive photographs, figs. 2 and 3, of a 35,000-volt discharge over the surfaces of glass and mica discs, ten inches in diameter were also made. The peculiar network of fiery streamers spreading over the surface of a solid dielectric has been described by many experimenters, but we do not recollect having seen a photograph of this before. The time of exposure was in each case about $\frac{1}{10}$th of a second. A shorter exposure shows fewer streamers and it is possible that for each alternation there is but one path from the upper to the lower surface. The quantity of current used is very small. Two distinct sounds accompany this discharge, one a loud crackling sound, the other the peculiar hum due to the alternating current dynamo.

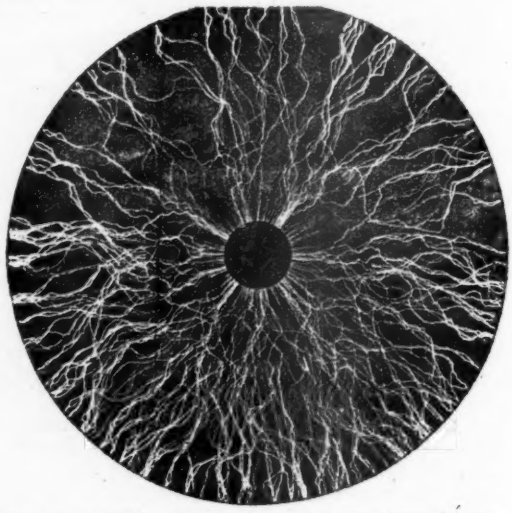


FIG. 2.—35,000-VOLT DISCHARGE OVER THE SURFACE OF A GLASS DISC, 10 INCHES IN DIAMETER

One terminal of the 35,000-volt circuit given one turn around an incandescent lamp bulb fills the lamp with a bluish light and at the same time violently agitates the filament, which is usually broken after a few seconds.

The static induction of one terminal upon the other may be shown by winding a helix of fine copper wire on the outside of a glass tube and placing a similar helix upon

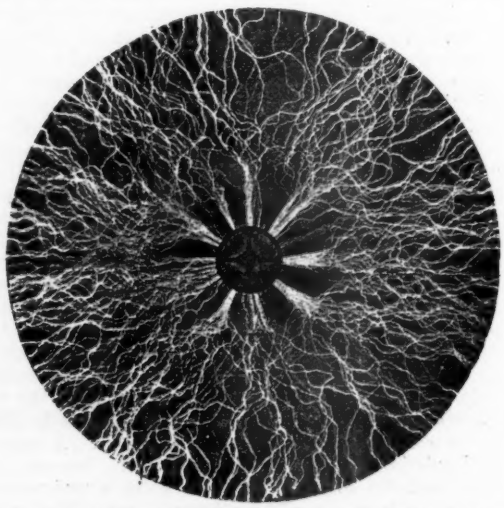


FIG. 3.—35,000-VOLT DISCHARGE OVER THE SURFACE OF A MICA DISC 10 INCHES IN DIAMETER.

the inside. On connecting the high potential terminals to the two coils, the tube is filled with bluish light and every few seconds a discharge takes place from one spiral to the other through four or five inches of air around the end of the tube. A few plates of glass built up with tinfoil as a condenser give the same phenomena with increased intensity. After a few seconds the glass breaks down, being either pierced by the current or cracked by the intense heat of the discharge.

The Westinghouse Company has now a 100,000-volt apparatus with variable frequencies, and they are experimenting with oil insulation. Up to the present it appears that oil insulation is better with high frequencies than with low. This confirms Hospitalier's experience.

The experiments are crude and no doubt miss many important points, but they are decidedly interesting.

ELECTRICITY AS APPLIED TO TORPEDO AND OTHER NAVAL PURPOSES.*

BY LIEUTENANT F. T. HAMILTON, R.N.

THE internal lighting of men-of-war has now become the rule instead of the exception; it is found that it is economical, clean, and convenient, and, except in the case of quite small vessels, where space does not admit of duplicating the dynamos, and the complement does not admit of telling off special men to tend the machinery, it is invariably fitted. A trial was made at one time of using the hull of the ship as a return. The advantage of such a manner of fitting is principally economy, and also a slightly diminished risk of having the wires cut by shot in action; the disadvantage is that with the earth return system a single leak at once disables a part of the circuit. The complete wire system is, therefore, always used now, an alternative system of candle lighting being always fitted as well in English men-of-war, the reason being, not so much to provide against breakdowns, as to provide against the contingency of not being able to light your fires, or of wanting to economise coal. A vessel of the *Latona* class would use about 5 tons of coal for keeping her internal lighting going for a week, and the space occupied by this amount of coal would stow candles sufficient to last the ship for nearly six months. As a general rule, electric lighting is a great economy and convenience, and, as such, we are right in employing it; but occasions may arise, especially in war, when the small amount of coal it uses cannot be spared, when no money could represent to us the value of a few extra tons of fuel.

With regard to the fittings for internal lighting, the cables are now made covered in lead, and are put up without any casing, the lead being considered to be ample protection.

With regard to the search light, its use has largely developed, many more being now carried; there is, however, still a great difference of opinion as to the best way of using it. Some prefer a large number of small lights (one war vessel having as many as 13), others prefer a smaller number of lights of high candle power; of course the more powerful light penetrates farthest, but it is open to the same objection as the market basket that contains all the eggs. On the other hand, a large number of lights must be confusing to those using them, and tend to make the ship very conspicuous. Another point connected with the search light that gives rise to great controversy is, whether it should be high or low; if high, the surface of water that is covered by the concentrated beam is very small, and consequently there is a difficulty in picking up an object; if low, some say that the rays striking the water are reflected upwards, and striking on the mist form a screen to objects beyond. There is one point on which every one is apparently agreed, that the farther you go from the source of the search light, the better you see the objects it illuminates; for this reason, the smallest gunboats are given a powerful electrical apparatus, as they are always likely to be useful as electric light stations for the larger ships. A vessel is also sometimes supplied with portable search light plant, so that it can be landed at a suitable point commanding the anchorage, and well away from the ship herself.

Secondary batteries are very convenient for burning electric light, driving electric boats, and for any other purpose for which a powerful and constant current is required. The objections to their use are their weight, the time they take to charge, and the fact that they require most careful handling, and are easily injured if neglected, or charged or discharged too quickly.

A light and efficient accumulator is a boon we must look forward to yet; with it, steam launches would soon become a thing of the past, and we should be within a measurable distance of the flying machine.

Whilst on the subject of cells and batteries, I will point out a late development of the primary battery which bids fair to come largely into use, that is, the so-called dry cell. Hellesen's cells, which are an example of this type, were used in the small electric boat on the lake at the Naval Exhibition, for working a small magnet in the boat; they remained in use the whole time the Exhibition was open, which proves that they have great lasting power. They are excellent for ringing bells and such like work, and promise well even for batteries, for firing detonators and charges, under some circumstances.

Different patterns of ship electrical telegraphs have now been in use for some time; the difficulties to be overcome with regard to them are, first, the efficiency, under circumstances of sea service, of the batteries or other sources of electricity that work them, and, secondly, that they should indicate accurately at whatever speed the handle is moved, as however careful an officer of the watch may be he will naturally push the engine room telegraph over with a jerk if he finds that his ship is just going to run into something. To get over the difficulty of the batteries nearly every known source of electricity has been tried. The current required should be large, as the larger it is the less delicate the instruments need be; naturally, therefore, secondary batteries have been tried, but by reason of their delicacy, and the care required in their use they are not altogether a success. Primary batteries, as being more easily repaired or replaced, have been more largely used, but it is difficult to get great power from them. It is also proposed to work telegraphs with the direct current from the dynamo machine; an instrument of this description has been invented by Mr. Richards, a constructor in the Admiralty. It only takes half the amount of current necessary to light one lamp, and that only intermittently, whilst it is in actual motion; and as in our modern ships we have ample dynamo power, and always have steam to work it when under way, there seems to be no objection to using the dynamo as our source of electricity; this is, however, quite a new departure, and we have not yet got any practical experience of its working.

The machine that is at present most commonly in use is Willis's, and the latest improvement of it, the Willis & Robinson's telegraph.* This instrument can be worked either by secondary or by primary batteries. The great point in its favour is that it cannot be thrown out of adjustment by being worked too rapidly, as the handle is not in direct connection with the electric mechanism. The fact of putting the handle over winds up, or extends or compresses a spring, which, in its turn, drives some clockwork; this makes the contacts; and no matter how angry or excited the officer of the watch may be, the clockwork will only cause the contacts to be made at a certain slow and deliberate pace, quite fast enough for all practical purposes, but not so fast as to incur any danger of upsetting the adjustments. Another good point is that should this instrument show the wrong indication through the handle being worked when the battery is disconnected for any purpose, or through any other cause, it will readjust itself, simply by putting the handle hard over.

Instruments of this description are used for engine-room telegraphs, helm telegraphs and indicators, and for distance indicators to telegraph the distance of the enemy or target from the officer taking the range to the guns. To prevent the possibility of mistakes, it is always advisable, in any instrument of this description, to have an answering dial, so that you can see that the man at the other end has received the correct signal.

A large ironclad now being built at the Forges et Chantiers de la Méditerranée is quite the most perfectly fitted ship, electrically speaking, that has ever been built; she has electricity for everything, and we shall have to refer to her more than once. Among other things she is to be fitted with a most elaborate system of telegraphs for all purposes. Messrs. Elliott are now preparing the instruments; they consist of engine-room telegraphs, helm telegraphs and indicators, distance indicators and telegraphs, and revolution indicators. These last are very ingenious instruments, invented by Spratt. The fact of pressing a button on the side of the instrument clears off any former record, and starts the clockwork, which goes for fifteen seconds; on the screw shaft is an electrical contact that is made four times in each revolution, at each contact the instrument indicates one; so that, at the completion of the fifteen seconds, the number shown is the number of revolutions the engines are making per minute.

Whilst on the subject of telegraphs, it will not be out of place to consider the question of electric logs. A difficulty has always been to keep the revolving contact water-tight; this has now been got over in Granville's log,† by making the log itself one plate of the battery for working the instrument, the iron hull of the ship the other plate, and the sea itself the exciting liquid, so that insulation is not required. It only remains, therefore, to decide what combination of metal with iron will give us the best result. Zinc gives a high electromotive force, but is not constant, as the sea water acting on the zinc oxidises it and the strength fails, necessitating constant cleaning. Plumbago gives the best results altogether, as it makes a cell strong enough to work one dial, and does not oxidise at all. If it is desired to use more than one indicator, the difficulty is easily got over by making the small current from the log work a small and delicate relay, through which a powerful battery on board could be made to work as many instruments as you like. A combination of this instrument with a revolution indicator, such as I have just described, would enable you to read the speed at any minute by only pressing a button and waiting a few seconds until the counter had finished counting.

A use of the telegraph that we are hearing a good deal about at present is for communication with outlying lighthouses and lightships. There are two difficulties in the way; first, that of getting the wire on board the lightships that must of necessity swing to the wind or tide, or through the surf that is sure to be continually beating on the rocks round an outlying lighthouse.

A plan has, however, been patented by the Telegraph Construction and Maintenance Company, by which communication can be made to both lighthouses and lightships without the cable actually going on board them at all. The plan is this. A twin cable is led out from the shore to within about a quarter of a mile of the lighthouse or ship, the cores are then forked out, and end in large earth plates about one-quarter of a mile apart, one on either side of the place we want to telegraph to. Two earth plates are put overboard, one from either end of the lightship, or on either side of the lighthouse. If now Morse signals are sent along the twin cable from the shore, using an interrupted current produced by a clockwork sounder, they can be distinctly heard in a telephone on board the lightship. This plan is now under trial, and, I am told, is likely to get over the difficulty of communication.

But the second difficulty is not so easily disposed of. At present lighthouses and lightships are supposed to be exempt from attack in war time; but if we have telegraphs to them, it will be a sore temptation to use them as outlying signal stations for reporting the enemy's movements, and even if our morality is proof against the temptation, what enemy is going to give us credit for such correct behaviour? The result is, we should, as soon as war is declared, have either to remove them or protect them. The impossibility of protecting them is shown when I point out that there are over 50 round the coasts of the British Isles that an enemy might suppose to be connected by telegraph, and that he would therefore be quite justified in destroying.

The telephone is not of much use in a man-of-war, as even in ordinary circumstances the noise of the engines, and the noises inseparable from having several men living together in a confined space, make it difficult to hear through; and in action it would of course be absolutely useless. It has also been given up by divers, as they prefer a voice tube, but it is of great use for running temporary lines for signalling during shore operations, or for keeping up communication between different parts of a mine field, whilst laying mines for the defence of an anchorage.

* Abstract of paper read before the Royal United Service Institution.

* ELECTRICAL REVIEW, February 1st, 1889.

† ELECTRICAL REVIEW, January 30th, 1891.

Another way in which electricity helps us in signalling is by using either coloured or flashing electric lights. There is one system in which three lanterns are used, from which you can at will show either a red or white light. Thus if three lights are used together we can get eight combinations, and if two lights are used as well four more combinations may be obtained. These twelve would be quite sufficient for the few important signals that are required to be carried out quickly at night, such as large alterations of course, stopping engines, or starting. The system has also been largely extended, so as to make a complete code, by increasing the number of lanterns and using, in addition, indicator lights to point out the chapters of the signal book to which the number shown refers. In connection with this system, an Officer of the Austrian Navy has introduced an ingenious but somewhat elaborate switch, whereby the operator only has to set the number of the sign on a keyboard, turn the switch, and the proper signal is automatically shown.

Great difficulty has been found to make the flashing system work properly. There are two ways in which flashes can be produced, first, by veiling the light, and, secondly, by extinguishing it; if a light is extinguished by a switch in the ordinary manner, you will notice that it takes a very long time for the carbon to cool down to blackness, and, being cold, it also takes a long time to warm up again to incandescence; the higher the candle power of the lamp, and, therefore, the thicker the carbon thread, the longer this takes. The result is, either the flashes have to be so slow that it is difficult to take in the signal, or they are all blurred together and it is impossible. Another difficulty is, that when the current carried through a switch is large, as it is in the case of lamps of high candle power, each break of the current causes a spark that in a short time burns up the switch.

Therefore, to get over these difficulties, several attempts have been made to produce the flash by veiling a light that is continuously burning; they have not been satisfactory, as the fact that the mechanism must be always exposed to bad weather and to violent alternations of heat and cold, renders a delicate instrument impossible; whilst, of course, a large and heavy instrument cannot be placed aloft where, for distant signalling, the flashing light is principally required.

We therefore have to fall back again on the extinguishing system and try to get over the difficulties; this has been done very fairly successfully in the following manner:—So as to allow the carbons to cool quickly, instead of having one thick fibre, we have a number of thin ones; the lamp so made is called a multiple-fibred lamp; and, as a still further development of the same principle, we put each of the small fibres into a small lamp of its own. This improvement gives us two advantages, first, there is better ventilation and, therefore, more rapid cooling of the fibres; and, secondly, we get rid of the risk of one loop catching over another owing to vibration of the lamp. The incandescence is more rapidly obtained by having a resistance inserted in shunt with the key, which allows a small current to be constantly running through the lamp, not powerful enough to give any light, but only sufficient to keep the fibres at a very dull red heat; this resistance also helps to get rid of the spark at the switch when turning the light off; and this object is further helped by having a condenser placed so that each coating is in connection with one side of the key. A light of this description, placed on the truck of a ship, is very useful for distant signalling, but does not, of course, have quite the range that the search light has when thrown up into the sky, especially when there are heavy clouds about that can be illuminated by the beam; this method, although slow, still remains the best for very distant work.

The next point on our programme is range-finding. Lieutenant Fiske, of the American Navy, has invented a very ingenious plan,* by which electricity can be made to assist us in finding the range of a target or enemy's ship at sea.

We will now consider the application of electricity to motors. Their use for various purposes has increased very largely of late years, and they are a great convenience, owing to the ease with which the power is conveyed to them (wires being all that is required), and to the portability of the machine itself whilst working. An example of their portability is the electric drilling machine now largely used in the construction of iron ships.

For working guns in ships the means usually adopted are hydraulics, and in point of economy there is no doubt that it is far the best, for one great reason, that it can be applied direct to the work it has to do without the intervention of gearing.

Nevertheless in one or two American ships and in this new ironclad we have already mentioned as building at the Forges et Chantiers electricity has been adopted, I presume on account of the quality I mentioned above, viz., that it lends itself to facilitating the transmission of power through water-tight bulkheads without impairing their usefulness, and also to the fact that the wires are so much easier to repair if damaged in action than pipes.

This vessel is armed with four 24-cm. guns mounted *en barbette*, one forward, one aft, and one on each broadside, and also four pairs of 12-cm. Q.F. guns on twin mountings, the ammunition supply being between them. The larger guns are both trained and supplied with ammunition by electricity, whilst the smaller guns have only electrical ammunition supply. For training the 24-cm. guns, two motors are supplied to each, one being spare; the motor revolves a sprocket wheel by means of a worm and wheel; this sprocket wheel gears into an endless pitch chain which encircles the trunk of the mounting, itself an integral part of the revolving platform. This trunk also forms the ammunition lift, and the ammunition is hoisted through it by another endless pitch chain actuated by a smaller motor. The ammunition hoists at the smaller guns are worked in a similar manner. All the motors are therefore well down below, and are, in fact under the armoured deck, and in most cases, if not all, they are near steam engines, so it is difficult to see what advantage is gained, as the steam itself might have been used, but I believe the electricity is a duplication of power. That is, a standby in case the steam or hydraulics breaks down. The electricity in this case is produced by two very large dynamos driven by engines that appear to be of about 40 horse-power.

There are two points of advantage in the electrical boat over the steamboat that should be noticed: first, that in the former we do not require to carry any extra weight, such as coal and fresh water to keep the engines going; and, secondly, that we can stow the weights in the electric boat to better advantage than in the steamboat, as it does not matter where the batteries are placed, so long as they are in the boat; therefore, as they need not be high, we are enabled to build a boat of deeper keel and consequently finer lines. This advantage does not seem to have been made full use of yet; when it is, perhaps we may get rather better comparative results between the two modes of propulsion.

We must now pass for a few moments to the question of firing guns by electricity. We have been in the habit of using what is termed a "detector," that is, a galvanometer, so that we can see at any time if the circuit is complete. An improvement on this has been recently introduced by which, instead of seeing, we can hear if the circuit is correct by substituting a sounder for the detector. This instrument has been brought out by Messrs. Armstrong.

Whilst on the subject of guns, I may as well also mention night sights, or a plan for illuminating the sights at night so that aiming is made much easier. As an example, I will take those patented by Captain Grenfell, which consist of two very small incandescent lamps, the current for which is obtained from small primary or secondary cells. The lights themselves are screened from the eye, but throw their light on inclined bars which form the sights. A switch is introduced between the battery and the light, with a resistance in it, so that the brilliancy of the light can be regulated to suit different conditions of atmosphere. These sights will probably very much increase the accuracy of night firing.

With regard to torpedoes proper, that is, mobile charges as distinguished from stationary charges or mines, electricity is still used both as a means of steering torpedoes and also propelling them. For propelling them, as one might expect from what we have seen of the difficulties of electric boats, the source of electricity cannot be contained in the torpedo itself, with any hope of attaining a high speed. We have, therefore, to fall back on the plan of having a cable between the torpedo and the source of power, for conveying the electric current to it. The most successful torpedo of this type is the Sims-Edison,* which has been going now for some years.

Attempts have been made lately to use it from ships under way, and there is, no doubt, that so far as the machinery that it is necessary to carry is concerned, it can perfectly be done. But its proper sphere of usefulness is undoubtedly as an auxiliary to harbour defence. The difficulty with it will, I am afraid, always be the cable, for this reason. Electrical power can be obtained in two ways; we can either have high electromotive force and small current, or low electromotive force and large current. Either combination will give the same result; just as in the use of water, a high pressure and small quantity can be made to do the same work as a low pressure and large quantity. Now, if the electrical current running through the cable to the motor in the torpedo is very large, the cable must be large and heavy; and the torpedo itself, which has to hold the cable that is to be paid out, must also be large, so as to be able to carry the weight. It is a great advantage, therefore, to reduce the current and increase the electromotive force, but we then come face to face with another difficulty, that if we have high electromotive force, we must have extra good insulation on the cable conveying the electricity, as a leak in the insulation will be immediately fatal to the working of the motor.

Therefore we want to hit off a mean that, whilst giving us a small current and therefore light conductor, will not unduly increase the electromotive force beyond what the insulation of a flexible and light cable is able to stand. In the end it will probably be found that the users of this torpedo will have to rest satisfied with a cable that will be efficient for one or two runs of the torpedo only, but will not stand more use than that. This, of course, means extra expense, a small matter in war time.

* Electrical Review, February 21st, 1890.

* Electrical Review, August 15th, 1890.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

An ordinary general meeting of the Institution was held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday evening, May 12th, Prof. W. E. Ayrton, F.R.S., President, in the chair.

The minutes of the previous ordinary general meeting having been read and approved, and the names of new candidates announced, the discussion on Mr. Trotter's paper, "Notes on the Light of the Electric Arc," was resumed.

Dr. Fleming: There are some points in Mr. Trotter's valuable paper which interest me particularly, because they cover ground which I have been occupied in with some experiments at various times. One of these, upon which I should like to make a few

remarks, is the result of introducing various vapours into the arc. Mr. Trotter mentions the Saunderson method of using a hydro-carbon in the arc. Now I happen to have made a great many experiments for Colonel Saunderson with his own arc lamp, and the results, which I have here, some of them, are interesting. I may perhaps explain, for the benefit of those who do not know the exact construction, that Saunderson took for the bottom carbon a hollow carbon that had an asbestos wick up it instead of the usual soft core, and at the bottom of the carbon there was a metal vessel in which he placed some paraffin, some substance like vaseline, or some easily fusible paraffin; that was conducted by the asbestos wick up the bottom carbon, and then introduced into the arc. I made a good many experiments at his request in Mr. Apps's workshop at one time—in March, 1890, I find by my notes—on the effect of introducing such vapours into the arc. The experiments were made with a photometer of the usual type, having a special arrangement adapted for such purposes, and the standard of light was a 5 C.P. incandescent lamp, which was carefully standardised before and after the experiments against a Vernon-Harcourt standard. Then the arc lamp used was a hand-regulated arc lamp; we found that was the best method, as our skilled assistant, with his hand on the slow motion screw and his eye on the voltmeter, could do better than any automatic mechanism, and the experiments consisted in measuring the photometric intensity in various directions, first for a pair of ordinary carbons, and then for exactly the same sized carbons in the same arc, only the bottom carbon was cored and had the vaseline introduced into the metal vessel. The size of the carbon was: the upper or positive in all cases a good-cored 13 mm. carbon, and the lower carbon was either a similar good-cored 13 mm. carbon, or else an improved tubular carbon supplied with the paraffin oil by a tube in a vessel; and the results of these observations were then plotted down in the usual polar curve for the different angles. That is the arc [indicating on blackboard] plotted down in the usual polar curve, taking the red rays as excluded by a good ruby-red glass, tolerably monochromatic, and then taking also a good signal-green glass, roughly, green light; and taking the red rays first, it was found with the ordinary carbons we got the usual polar curve of certain dimensions, and on substituting for the bottom carbon the hollow Saunderson carbon with the paraffin in it and drawing the same polar curve for the red rays, it lay outside the other altogether; there was not only more light in any direction, but more light in all directions. And with the same curves drawn for the green rays, a different curve being taken for the improved or hollow carbon, that was found to lie outside the other, and the ratio of these at the angle of greatest intensity, maximum photometric intensity, was somewhere about 30° or 40° in that lamp. Taking the intensity of the red ray for the ordinary carbon in the horizontal direction as an inch, then the maximum red rays for the ordinary carbons in the direction of and 30° below the horizon, was 3·44; the same rays in the improved carbon in the horizontal direction was 1·21, and in the direction of maximum intensity it was 4. The results were then converted into a figure which Mr. Trotter says has no very definite meaning, the mean spherical candle-power; but still it was a definite operation performed on those in all directions, and the result of that was to show that the mean spherical red light was improved 26 per cent., and the mean spherical green light 24 or 25 per cent., not very different from one another, so that the introduction of this vapour into the arc had the effect of increasing that mean spherical candle-power in those ratios; and it was noticed that the introduction of this vapour into the arc greatly lengthened the arc. The length of the arc was measured by projecting it with the lens on a piece of cardboard and measuring the length of the arc compared with a piece of metal an inch long projected at the same time. We found the arc about twice as long with the same voltage when using the hollow carbons with oil compared with its length with the ordinary carbons. Moreover, it was noticeable that there was certainly much less cratering of the positive carbon when the prepared carbon was used. Those results at the time were interesting; but I have not heard much since of the application of this lamp in practice. The device seems a very simple and practical one, for the oil vessel used was a very easy thing to fill, and the wick up the hollow carbon was certainly an improvement over attempts made in the same direction before; the wick seemed to have the effect of supplying the hydro-carbon to the arc very regularly and uniformly. Then a word or two on that table of Mr. Trotter's, in which he gives us the intensity of the light emitted per unit of surface from different sources of radiation, which are quoted from the results of some work by Weber, of Breslau, taking incandescent platinum as the unit. That table is a very interesting one, showing the very wide range over which this luminous surface intensity extends for different sources of illumination. There is no mention in that table of a source of light which we might certainly have expected to find there, namely, an incandescent lamp. I can, perhaps, supply that figure which is missing. It comes out very nearly identical with that of platinum. I suppose the standard of surface intensity which is there taken is the surface intensity of illumination from platinum not very far below its melting point, and that is 120 candles per square inch. Now, in my incandescent lamp, if you measure the surface of the carbon and measure the mean candle-power of the lamp, you will find that it comes out at very nearly the same number, namely, 120. It is something as follows: This usually was about the rate of $\frac{1}{4}$th of a candle per inch mil. That is to say, if you take a unit of surface whose length is an inch and whose paralleled longest side is one inch, and whose shortest side is $\frac{1}{1000}$th of an inch, or a mil, and call it an inch mil, it is something at that rate. Mr. Trotter's figure in that table for an arc lamp, I suppose the crater, comes out at 40 candles per inch mil. Therefore, comparing it with an incandescent lamp, it is in the ratio of 40 to $\frac{1}{4}$th, or 320 to 1, a very striking difference indeed, and one point of interest which ought to be decided, if it is possible to do so by experiment, is what ratio exists between those surface intensities and the true temperature of the surface; in other words, what function of the temperature of the surface is that surface intensity? It must be something like a cube or a fourth part, for we know the temperature of a filament of an incandescent lamp is something not very far removed from that of melting platinum, 2,000° C. As to the temperature of the crater of an arc, that is much more uncertain. Suppose we take it at 8,000° C., that is to say, four times the temperature of the filament of an incandescent lamp; then the temperatures of these surfaces are in the ratio of 4 to 1; but the surface intensities are in the ratio of 320 to 1, which is more than the fourth part. That point is certainly one which needs further investigation. Mr. Trotter does not believe much in the measurement of mean spherical candle-power, and it is very true there is not very much meaning attachable to that term. Still, there are occasions when one requires to measure not merely the radiation of an arc in a particular direction, but to have some factor which gives a conception of the total radiation of the arc in different directions, and there is a very simple construction which is given by Rousseau for determining that from the polar curves. All that we have to do is to take the radii of the polar curve, and to take a line describing a semi-circle with that arc as the centre, and taking these radii, continuing them out towards the semi-circle which is described with the arc in the centre, which includes the polar curve, to project over a horizontal line, and then to take them vertically out [indicating] on these horizontal ordinates, a length equal to the radius of the polar curve which represents the photometrical intensity in that direction, and then you get a curve in that form [indicating]. Then integrating the area of that curve with the planimeter, gives you the mean spherical candle-power. There is also a method which I have tried on one occasion, and which is a simple one, for obtaining the ratio between the luminous intensities of the arc in different directions, by comparing them with the intensity in the horizontal direction. When you are taking the photometric values of an arc lamp in different directions, you have to do one of two things: you either have to tilt the arc lamp, which is objectionable, because it does affect the arc, or raise the lamp up to a great height, in order to get at the ray you want to compare. One simple way of getting round that difficulty is, by a single mirror, to compare the intensity of any ray coming off at any angle from the arc with the light coming off from the arc in a horizontal direction, and then afterwards, when you have obtained these ratios all round the arc, you can standardise the arc in a horizontal direction. Mr. Trotter has not given us in his paper any comparisons between continuous current arcs and alternate current arcs. I think that is a point on which there is still room for investigation. Some time ago I commenced an investigation, which has never yet been completed, on a comparison between continuous and alternate current arc lamps. I had an idea that there was an intrinsic inferiority in the alternate current arc. I began by making a good arc lamp adapted for working either with an alternating current or with continuous currents, and determining the mean spherical candle-power of the arc taken from the polar curve, comparing that with the watts expended in the arc, and drawing a curve, or rather a series of curves, of this kind [indicating], the horizontal distances being watts expended in the arc, and the vertical distances representing candle-power—that was done for different rays for alternate current arcs; for red rays it was very nearly a straight line. The curves are here, and if anyone wishes to see them, I shall be happy to show them after the meeting. I only stopped for want of better means of measuring the power taken up in an alternating arc. I find since that Prof. Ayrton has been working at it, and it is in better hands.

Sir DAVID SALOMONS: I see Mr. Trotter, in his very interesting paper, has started very early with these words: "A little consideration will show that the effect is precisely and identically the same as though the end of the positive carbon were flat." That is not strictly true. And afterwards he has used all the arguments favourable to the surface of the carbon being cup-shaped, and therefore he arrives at the truth. I will just point out what I mean on the board. If that [indicating] were the positive carbon, and it were flat, you have then the normal; consider that the surface, the light issuing, omitting for a moment the refractive index, it will gradually get less as you get more inclined, or less inclined, to this surface, so that if this carbon were really a flat surface it would be perfectly valueless for illuminating purposes, for the greatest quantity of light would be here [indicating] with the normal, and therefore shielded by the negative carbon. But the fact of that being cup-shaped, you have a normal carbon, and therefore the light will be at a right angle from the source of light until you come to the line, when the carbon shields it. If the carbon did burn flat, all the advantages got from the arc lamp would be gone, and it would be perfectly useless to attempt to use it until you made it burn cup-shaped.

Mr. R. W. WEEKES: When working at the Central Institution, with the help of Mr. Thornton and another, I had a lot of work to do with the arc lamp. We wished to find out how the light varied with the length of arc if we kept the value of watts constant and the current as much as possible, only increasing the volts as the light increased. We wanted to use in one case a very hard carbon, and we found then if we took four readings in every direction, at every angle, if we took the mean of the four, we did not get within 5 per cent. of the real value of the light in that direction. We always compared the light with the standard candle. So we devised an apparatus with which we compared the horizontal ray with the ray going in any other direction. We proposed to make a framework of wood, and to have this about 6 feet long, and then with a reflector here [indicating] and there, we always got a horizontal ray from this side in the photometer, which consisted either of paraffin blocks or ground glass. Here [indicating] we had a reflector which you could move, and you could read on the scale here [indicating] the angle at which the light came. Setting this to the angle required, and moving up or down

until you get the light deflected correctly in this aperture, and by sliding this you get what relation the light in the horizontal direction bears to it here. The advantage was that you could always get the distances off the direction. By moving this along the rails you make connection by means of a knife-edge, so that the arc should always come directly under the knife-edge and get the distance here. I regret that we had not time to finish the work before we left the Central Institute, but I understand it is being proceeded with.

Mr. Carter: I should like to occupy your attention for a few minutes to make a few remarks on some observations I have been making since the paper was read. I would call attention in the first place to a sentence in the paper in which is a quotation from a paper read in 1889 by Dr. Silvanus Thompson on "The Arc Lamp and its Mechanism." The sentence is this: "It is as impossible to raise carbon above one degree of incandescence of the crater of the arc as it is to raise water above boiling point or ice above melting point. No substance has yet been suggested for 'improving' arc lamp carbons which is less volatile than carbon." Dr. Fleming has already mentioned one method of increasing the efficiency of an arc lamp by the introduction of what I may call foreign material. My remarks will be purely of theoretical interest I think, but it has occurred to me that there is another method of raising the temperature of the arc. According to the theory of heat, we know that the boiling point of a liquid depends upon the pressure which the liquid supports, the pressure of the vapour; and if the arc were placed in an atmosphere subjecting the vapour of the carbon to a higher pressure, the carbon would necessarily boil, as it were, or vapourise at a higher temperature. Consequently we should have the surface of the carbon at a higher temperature, and we should therefore have a higher efficiency, for the efficiency of any light source is a direct function of the temperature; raise the temperature and you increase the efficiency. For instance, the temperature of an incandescent lamp, 2,000° C., gives an efficiency in luminous rays of 6 per cent. I believe the temperature of the arc, as given by Sir William Siemens, is not 8,000° C., but 3,000° C. I can hardly understand that there can be so much difference between the arc and incandescent light, and I find the figure 3,000° C. mentioned as the temperature of the crater. Now, if we assume, and I think we have a perfect right to assume, that the saturation curve of carbon vapour resembles somewhat the saturation curve of steam, then we can calculate approximately what the rise of temperature will be with a certain increase of pressure, and I have estimated if we subject the arc to a pressure of eight atmospheres, we shall get a rise of temperature of the carbon of approximately 1,200°; that is, more than the difference between the arc and the glow lamp. Consequently, with the introduction of any foreign material we can get a higher degree of illumination from the arc. I do not say that this is of any practical value for ordinary work; it may be of use in lighthouse work, and for experimental work. This, of course, will increase the efficiency of the lamp; it would also diminish the size of the carbons, and consequently would screen less light; we should have more light visible; the negative carbon would not cut off so much light as in the case of a larger carbon, because you would have a smaller area of light for the same candle power. The effect of this would also be, according to the kinetic theory of heat that, you could work with a greater length of arc, because of the higher pressure and temperature; the striking distance would be increased. Speaking on another point, I have made a calculation on the probable amount of energy consumed in overcoming the back E.M.F., which, of course, is useful energy, but it involves a very high E.M.F., 39 volts to start with; you cannot get an arc under that. Assuming all the carbon is vapourised in this way, the whole of the carbon that disappears from the positive carbon is vapourised directly by the electrical action—electro-vapourised as it were—then we have a latent heat of 400,000 water-gramme degrees C. for the same amount of carbon; whereas if we assume that only the difference between the positive and negative carbon is thus vapourised by direct electrical action, we have a still higher electrical latent heat of 1,030,000 water-gramme degrees C. These are only approximate figures, which I have worked out this week, for the latent heat of vapours of one gramme of carbon difference between the positive and negative. Of course it is difficult to say how much of the positive is deposited on the negative. I believe not a great deal. I believe the peak on the negative is due to the absence of an oxydation agent, which would account for the inner portion not being burnt away, whereas the outer portion at a higher temperature, being exposed to the effect of the atmosphere, would account for the peak. I am now about to make some experiments to ascertain what the exact amount of the positive carbon deposited on the negative is. I am sorry I have not been able to bring the complete results to the meeting, but I hope at some future time to give the figures of those results.

Prof. Silvanus Thompson communicated the following, which was read by Prof. Perry: Mr. Trotter's paper is so complete and satisfactory that it leaves little room for discussion beyond congratulating him upon the very admirable way in which he has straightened out the crooked problem of the distribution of light from the arc lamp. It has been long known in a general way that the peculiar curves of distribution of light were occasioned by the shadow of the lower carbon. But Mr. Trotter's investigation has put the matter upon a new and sound basis of observation. His intensely geometrical mode of viewing all matters has led him to discuss the arc lamp from a novel standpoint, and to give us the true solution of the problem. It might be worth while to re-examine, by the light of these researches, the curves given some 12 or 14 years ago in the *Journal* of this Institution, for the distribution of light from the Jablochkoff candle. Doubtless these curves would also prove amenable to the same sort of geometrical treatment. The starting point of Mr. Trotter's investigation is the recognition of the fact that the intrinsic brightness per square millimetre of the carbon surface of the crater is a fixed quantity, being due to the incandescence of a determinate substance—carbon—and at a temperature which is also determinate, being fixed by the physical conditions of its production. It also necessarily follows that, so far as the actual crater is concerned, the light emitted is always of precisely the same composition; that is to say, the various kinds of waves emitted, red, green, blue, &c., are always present in the same proportion. In the recognition of this fact, the name of Captain Abney should not be forgotten, since he has made it the basis of much of his photometrical work during recent years. I would now throw out the suggestion whether, in view of the unchanging quality of the light of the crater of the electric arc, it is not worth while to reconsider the question of a standard of light, and adopt as a unit of light the light emitted by a square millimetre of crater. It is certainly a more practical unit than the square millimetre of molten platinum used by Violle; and it is preferable, by reason of its greater whiteness, to the flame standards (such as the pentane flame, the amyl acetate flame, and the Carcel lamp) that have been adopted from time to time. I omit the sperm candle and the Methven gas standard as being too unscientific to be put into comparison. It is to be hoped that Mr. Trotter will be encouraged to complete his experiments on coloured shades, so as to give us a real daylight illumination. It is obvious that such shades can be used with greater advantage in conjunction with electric lamps (whether arc or incandescent) with far greater facility than with any flame lamps. Certainly, artists and all lovers of art will welcome such a means of lighting rooms. The introduction of such combinations will extend the use of electric illumination.

Mr. James Shoolbred: Not having had the advantage of being present here when the paper was read, I will not attempt to discuss this very interesting and most valuable communication. I rise more for the purpose of asking Mr. Trotter a question. He refers to two communications published in *La Lumière Electrique*, one by M. Rousseau and the other by M. Palaz, as being interesting and containing some information with regard to polar curves. May I ask if he remembers the date of those communications? The reason I ask is that some very interesting curves, the result of experiments carried out by Messrs. Sauttier-Lemonnier in Paris, were noticed first before the Society of Arts in 1878, and those, and also some curves of alternate current machines, taken from experiments carried out by M. Allard, of the French Lighthouse Department, appeared afterwards in a small publication in the year 1879. I would like to know whether they are included in those researches mentioned by M. Rousseau. They appeared remarkably interesting at the time, and the late Sir William Siemens mentioned that, as far as he knew, it was the first time this peculiar polar curve, especially of the continous current machine, was mentioned. I ask, therefore, if he will kindly give the date at which those communications were made; are they included in those researches?

The President: Before calling on Mr. Trotter I want to make one or two observations, partly in reference to some remarks made on the last occasion. Mr. Mordey considered that he was justified in calling the light given off by a 10 ampère Brush lamp 2,000 and something candles because the jury at the Crystal Palace in 1881 had reported that such was the efficiency of the Brush lamp. He coupled my name with that jury, and wished, therefore, to imply that the results were immaculate. However, I was not on that particular jury, and therefore am not responsible for the accuracy or inaccuracy of their results. Mr. Carter has assumed in his remarks this evening that the back E.M.F. is a perfectly definite and known number. I wish just to point out in passing that I am not aware of any tests whatever that have shown that there is a back E.M.F., or that it has a value of 39 ampères. It is frequently stated that that is the case, but I am not aware of any tests that substantiate the assumption that there is a back E.M.F.

Mr. Carter: I merely took the figure given by Dr. Thompson.

The President: He does not make any test that I am aware of or quote any test. It is an interesting point, but that is the state of our knowledge on the subject. Dr. Fleming's remarks with reference to the Saunderson lamp opened out a wide subject, about which I would like to say a good deal, but in view of the other paper which I hope is coming on in a few minutes, I refrain from doing so. I may mention, however, in passing, that a possible explanation of the greater light, red and green, given off by the arc with the paraffin oil introduced may be simply due to the fact that they were able in that way to get a greater length of arc, and therefore less shading of the top carbon by the lower. Dr. Fleming mentions that he got a much greater length with similar volts and also with the same current. In other words, the same power gives much greater length, but this greater length is much less shaded. The greater brightness of the arc probably is merely produced by greater length. There are many points in the paper which would call for observation and lead to interesting discussion, but I refrain from being drawn from my duty to enter into them. I may, however, say a word or two about the curves at the end of the paper. They are of very great interest indeed. The question of producing artificially by means of arc or incandescent lamps, especially with arc lamps, light of particular colours, is a subject which has interested me for some years past. On two occasions at the Royal Academy I have urged on Dr. Russell, whose name is mentioned in this paper, and he has undertaken to bring before Sir Frederick Leighton, my views as to methods of arranging the pictures in the Royal Academy, and as to illuminating them with colour of a particular kind for a particular group of pictures, so as to produce not merely as good effects as those obtained in daytime, but, I hope, far better effects than the uncoloured sun gives. The question as to whether arc light is or is not blue with reference to white light is a subject which has been discussed backwards and forwards, and the advocates on each side consider that they are right. The explanation

of that is that they are both right. The arc light is blue relatively to white light, and the arc light is not blue relatively to white light. It all depends upon what you mean by white light. People talk about white light as though it were some definite thing. If by white light you mean sunlight during the day, the unclouded sun, or if you mean the light given off from the white clouds in the daytime, then undoubtedly the arc light is red compared with that, and not blue. You can easily test that by using what Mr. Trotter rather despises, red and green glasses. It is perfectly true, as he says, that you cannot combine the results obtained by red and green glasses; you cannot get the arithmetic mean, or the geometric mean, or the square root of the mean square, but I do not think that is any objection to making experiments with red and green glasses. In the same way you may speak about the experience of a person and the ability of a person, but you cannot take the arithmetic mean, or the geometric mean, or the square root of the mean square of that. Yet when judging of the value of a person you may think of his experience as compared with his ability. In the same way, when you want to speak of the arc lamp as so many candles, it all depends upon what you want to use the lamp for, whether to illuminate red roses or green leaves. The value of the arc lamp is very different in those two case; it may be two or three times as valuable for the one purpose as for the other. Therefore surely it is perfectly right to separate the two measurements. If you use the despised glasses you can at once compare the arc light with the sunlight. All you have to do is to get a balance with the photometer through green glasses; then looking through the red glass you see at once you have not a balance, and you see at once which is the brighter of the two. You will find under those circumstances that the arc light is red compared with the sun. But arc lights are as a rule used not in the daytime, but at night, and during the night white light is not sunlight. That, of course, brings us to the consideration of what is the definition of white light. I believe the proper definition is, what you see most of. Simply that. Now, up to the present time we have not seen most of arc lights during the evening. Therefore we have a particular standard during the evening, and in accordance with the standard we have adopted by experience the arc light is undoubtedly blue during the night. Also, the sunlight of the early morning gives a very bad and imperfect impression of white light when seen after you have been up during the night. If you take the daylight standard, then the early morning is the proper light, but if you take the night standard then the early morning is the wrong light. Of course, you may say that is introducing physiology and psychology, and other things, but you cannot help introducing them. Helmholtz some years ago made a very simple experiment. It was this: to see what was your estimation of distortion. He put a pair of spectacles, distorting glasses, on a willing subject; and it was found that after a comparatively short time a person wearing these ceased to have any feeling of distortion; looking through these glasses he saw everything perfectly correctly, and only saw things distorted when he took off the glasses. That is to say, the eyes quickly adapt themselves to a particular standard at a particular time. Well now, during the night, your standard is the gas and candle standard, and according to that standard, it is perfectly right to say the arc light is blue compared with white light; on the other hand it is quite right to say the arc is red, compared with white light during the day. I will now call on Mr. Trotter to reply.

Mr. A. P. TROTTER: I have to apologise to the meeting for not being able to show the experiments which have been a second time promised. The terminals are in that glass box, and have been there for ten days, but the insurance inspector has not been there. I hoped to have shown one or two other experiments, and, indeed, Mr. Higgins only took away the apparatus to make the experiments this afternoon, and I may say at once what that was. It was with reference to what Mr. Swinburne said, and what Prof. Silvanus Thompson has also suggested about using the crater as the unit of candle-power, that is a square millimeter of the crater. I should like to have shown you a point brought to my attention by Mr. Higgins, that the core of cored carbon is distinctly chiller than the rest of the carbon—it is not such a good carbon for ordinary purposes, but has a valuable function inside the arc. I suggested to Mr. Higgins to take a double carbon, as good as could be got, and also a piece of battery carbon, to split them down the middle and tie them together, to see if one crater was worse than the other. He did try the experiment this afternoon, rather rapidly, but found that the soft carbon flared and flamed so much that it was difficult to make a test. I fancy this was not only due to emissivity (?) but also to the volatility (?) of the carbon. The temperature must go down, and therefore I think it could hardly be depended upon for a unit of light. A question has been raised about alternate current arcs. I have had very little experience indeed with alternate current arcs. I am glad to hear Mr. Mordey has a high opinion of them, for that must mean that there is a great deal in them. I did once make an experiment with alternate current arcs. I will not mention names. When we had an official abstractor, we could always rely upon leaving it to his discretion, but now we are in the hands of newspaper people, and we cannot expect from them discretion or anything else; so I would rather not say anything. I asked a firm who are well known for using nothing else but alternate currents, if I might go down and inspect an alternating arc. An appointment was made, and I took round a very simple piece of apparatus, and wanted to inspect an arc with it. To my surprise I found that they set up specially an arc and a dynamo and resistances and switches for the purpose of my work. They had not an alternating arc in the place. He found them too much trouble to run and never used them. I always understood they were engaged in making a rectifying apparatus to facilitate the running of the arc. I look forward to seeing that arc at the Crystal Palace which Mr. Mordey promises. I ought to have mentioned General Festing's name in my paper, for he and Captain Abney are the greatest authorities on colour. I must pass very rapidly over the other matters. Mr. Mordey suggested that I had described the crater as being a horizontal disc where it is really concave, and Sir David Salomons has given his views on the subject. I will not dwell on that, but venture to disagree with them. I would like to have shown an experiment to demonstrate Mr. Mordey's point. I prepared a cylinder of cardboard about 6 inches in diameter, one end flat, and the other end a concave hemisphere, and those two painted with luminous paint, and exposed to bright light. If I had it here and showed you first the flat end and then the concave hemisphere, both self-luminous, I venture to say no one within six feet could have told which was which.

Sir DAVID SALOMONS: I did not say that. At the angle you made with the normal you could not tell the difference looking at it straight.

Mr. TROTTER: I say in the paper, no tilting will make it brighter. That is so. If that is a self-luminous gap, it must have the same effect, so far as I know, as a flat disc. There are other cases where light is falling on a substance, but that is not quite the same thing; the law of cosines is not strictly followed. But the reflecting power of a white surface, I think I am correct in saying, if it be a self-luminous surface, it is a mere question of what you may see, and not an angle. Mr. Mordey ventured to think I should not have said that the alternating arc had time to get cool, and said there was a thermal fly-wheel owing to the mass of carbon behind the crater which would have enough heat to keep the arc going. I should like to have shown on the screen the effect of reducing the current by a very small quantity in the arc. If you have the crater only focussed on the screen and reduce the current, you will see that crater change instantly; it will curdle all over in a sort of flocks, and in a very short time the crater will diminish and shrink in size; the current cannot support so large a crater. It is so instantaneous that I venture to think the luminous heat is actually on the surface. An incandescent lamp carbon is different; the heat is all the way through the filament; but there is not much of a thermal fly-wheel about the crater, and it is difficult to see how the luminosity could be the same as if it had the full current on one crater, upon which we depend for the light. I should like to have heard that Prof. Ayrton could have supported the 2,000 C.P. business. I do not know anybody else who has obtained that measurement, and I should imagine it could only be done by measuring with a photometer on each side and adding the results together. Dr. Fleming has mentioned the Saunderson carbon, and he says the maximum was given out at 30° to 40°, I think he said, below the horizon. I have given these numbers merely because they are the angles of incidence of those rays upon the ground, and it is as convenient as possible to keep only one set of degrees. They are from 90° downwards; but if they are only 30° to 40° the maximum is rather higher in the ordinary short arc. But the Saunderson arc, or any of those vapour arcs ought to give a longer arc. Well, it does give a longer arc; but the chief point of my paper is to show if this carbon [indicating] were drawn away, this part of the curve would be fuller; you would have no effect here. Therefore, I should have thought that the longer the arc you would have got the maximum shifted from here down to here [indicating]. That is what I should have thought; but I am surprised in these good results that nothing more has been heard of this. I think about ten months ago some American patented leading a wick up a groove outside instead of in the middle—a more palpable infringement it is impossible to conceive—but I have heard nothing more of that. My table does not contain a glow lamp. I mentioned the subject to Dr. Fleming, and there is no greater authority upon glow lamps; but one does not like to presume to ask about details about which we all want to know so much. We shall know sooner or later, very likely; but I did not want to meet with a refusal. 120 C.P. per square inch is interesting as showing that it is about the same as what you can heat platinum up to at the highest point you can get to, and shows what an enormous difference there would be if you could only heat the carbon up to the same point as you get in the arc, 320 times as great, and you can only not do so because the filament would blacken and volatilise. I have found you could do the spherical candle-power by the way I described, taking the area as bits of parabolas, or bits of ellipses, which you can measure out in a very few minutes, just cutting out a piece of paper and balancing it across a piece of pencil, in about one-fifth of the time it would take to plot it out and try it with the planimeter. I hardly think the rectangular method of Rousseau is very much in its favour. Dr. Fleming also said you must either tilt the arc or raise it to a great height in order to measure the angular rays. The method I have adopted in the instrument Mr. Higgins constructed at Finsbury gets over that difficulty; you merely swing it round and allow for the reflective power of a single mirror, which has the same angle. The question of raising the temperature of the arc has been mentioned by Mr. Carter. I am rather surprised to hear that even eight atmospheres would be enough to give you the effect. That reminds me about Mr. Swinburne's remarks as to the curious discrepancy about the light given by the sun per square inch, and that given by carbon. It wanted something 100 times blacker than carbon. A piece of the sun cut out and allowed to cool should be 100 times blacker than carbon. It is difficult to imagine anything blacker than carbon, but there is something. A hole cut out in the side of a box lined with black velvet is blacker and is sometimes used. But that will not account for the discrepancy. In the carbon I have been experimenting on, the core is distinctly more gray than the rest. But there is this to be said, that the pressure on the sun may be some tons per square inch, and it is very possible that that might so raise the temperature that we do get 100 times. I have checked that figure by some different experiments, and the figure of Weber seems to come out about right. And I think the temperature might account for that; however, I won't detain you with that. Mr. Shoolbred asked for dates, and the dates of Allard and Sautter-Lemonnier are no doubt before those. I fully ex-

pected to have heard some remarks to-night from a gentleman whose name I have not even heard on some experiments made at the Standardising Institution with coloured shades. I alluded when reading the paper to the fact that someone else was working at the same thing. There was a short letter in *Lightning*, and it alluded to the fact that some coloured shades had been used in experiments. I could not find the letter, but I understand that some experiments were made there with a gray screen, not so very blue but gray, and with a sun lamp, which is the *lampe soleil* resuscitated; they have got some very good results. Prof. Ayrton's remarks about back volts are, I think, interesting. I hunted through all the records I could get to find anything about back volts. I believe Prof. Ayrton, if he chose, could give us more information about that than anybody else, but I believe the experiments are not quite completed yet. Then Prof. Ayrton has given a very good reason for showing why you may talk about red and green, and his analogue of ability and experience is most excellent. He says white light is what you get most of, but that is not the case with ability and experience.

The President: Before proceeding to the next business I will move a hearty vote of thanks to Mr. Trotter for his interesting paper, which has given rise to an extremely interesting discussion.

ELECTRIC LIGHTING AT AMSTERDAM.

Since 1888 Amsterdam has had a small central station of 231 kilowatts, supplying 2,000 lamps of 16 C.P. distributed in the central part of the city only. This station generates 156 kilowatts direct current, distributed by means of overhead wires at 65 volts, and 75 kilowatts alternating current at 2,000 volts distributed by means of underground concentric mains. The Proprictary Electric Company to which the station belonged in 1890, obtained a concession for supplying current throughout the whole city during a period of 28 years, and on May 14th the company opened a new central station, in which the alternating current is generated exclusively. It is situated a short distance from the town. Steam is generated at a pressure of 8·5 kg. per square centimetre in 8 watertube boilers (Mac-Nicol patent). The boilers were manufactured by Messrs. Pétry-Déreux, at Duñen, Germany. One of the steam engines drives direct the alternating current dynamo, and one the exciters. They are horizontal and compound, and both the piston rods act at the ends of the main shaft, on the middle of which the alternate current dynamo (Ganz & Co. type) is built. One of these engines was exhibited at the Frankfort Exhibition last year, and was constructed by Messrs. H. Pauksch, of Landsberg-on-the-Warthe. Two similar engines were furnished by the Brünner Company in Silesia; they develop each 600 H.P. Besides these, three engines, a 300 H.P. horizontal and a 160 H.P. vertical engine are installed, each directly coupled to an alternator and its exciter. The whole power is 2,160 H.P., and the speed of the engines is 125 revolutions per minute; they are all provided with a condenser.

The dynamos are of the Ganz & Co. type, built by the Helios Company of Cologne (Ehrenfeld). They generate the current at a pressure of 2,000 volts, with 100 alternations per second; the larger ones develop 400 kilowatts each. The field magnets revolve on the shaft of the steam engine; the armature ring can be removed for sake of cleaning and repair. This dynamo was also exhibited in the Helios stand at the Frankfort Exhibition. The smaller dynamos are of the same type, and respectively 200 and 75 kilowatts, in total 1,500 kilowatts. The exciters are 4-pole compound dynamos with Gramme-wound armatures. They develop 20 kilowatts at 65—100 volts tension. All the magnets of alternating and direct current dynamos have laminated iron coils.

The current is distributed by means of concentric mains, manufactured by Messrs Felten and Guilleaume of Mühlheim-on-the-Rhine. They have a double lead casing, and contain at the inside of the exterior conductor another lead casing. They are tested at a pressure of 5,000 volts, and have 700 megohms insulation resistance per kilometre. They are laid down in wooden culverts filled with an asphalt mixture and covered with bricks. At various points in the city iron cable houses are erected, for the purpose of connecting a part of the network or cutting it out when necessary. Altogether 20 kilometres have been laid down.

The transformers are also manufactured by the Helios Company; they have a closed magnetic circuit, and transform from 2,000 volts down to 72 or 36. The latter is for the arc light, so that two arcs in tension may be supplied at the same time.

At present, 6,100 lamps of 16 C.P. are installed.

The current is delivered at the rate of 46 cents per kilowatt hour = 9½d. For a supply above 750 hours, a reduction of one-third is granted. Ganz & Co. and Frager meters will be used, for which no rent will be charged; but for connecting the house installation to the network an annual payment has to be made.

The small stations in the city will be closed, and the overhead wires that hitherto supplied a part of the consumers will be removed.

ELECTRIC AND CABLE RAILWAYS IN THE METROPOLIS.

The Board of Trade and the County Council.

The Parliamentary Committee on Electric and Cable Railways met again at the House of Lords on Thursday, May 12th, Mr. Stansfeld being in the chair. The other members of the committee present were: Lord Strafford, Lord Thring, Lord Shute, Mr. T. H. Bolton, Mr. Whitmore, Mr. Story Maskelyne, and Mr. Gathorne Hardy.

Mr. Coates, on behalf of several vestries and others interested, asked if it were the intention of the committee to determine whether the subsoil should be appropriated by the companies, and if he would be heard upon the subject.

The Chairman said the committee thought it would be well to enquire into the question, in view of any possible claims that might be made on the companies; and the representative of the vestries would therefore be heard.

Mr. Coates said the authorities had only a part interest in the subsoil.

The Chairman: Both vestries and private owners will have to be represented; but we can take only general views, without going too much into details. We do not want to hang up the matter. Whatever we think, it will have to go before the Select Committee. We are not prepared at this moment to say what we will do as to the point referred to; when we come to that part of the subject, we will consider it.

Major Hutchinson, an Inspector of the Board of Trade, said he had had his attention called to these schemes, but had not looked into them sufficiently to give a full opinion on them. He had no doubt electricity as a motive power would be sufficient to work the lines. It was not in his province to deal with the financial aspect of the question. The six schemes were all more or less better than the electric line now in operation. The gradients and the curves were less, and therefore better. The depth of the City and South London Railway below the bed of the river was 30 feet. In the Baker Street and Waterloo scheme it was much less. In one case, the depth below the bed of the river was only 6 feet, which was too little. Where these lines passed under the bed of the river it was very desirable that the tube should have a double skin—an inner and an outer—so that if a train ran off the track and broke the inner skin, there would be a skin remaining to prevent an in-rush of water. He did not think that in such a case both skins would be fractured. There would be a space between the two tubes. He had not considered the size of the proposed stations, but the approaches would probably be sufficient. The double skin would only be under the river, not throughout. The minimum depth under water of the existing line was 18 feet. He was giving his own opinions only—not those of the Board of Trade.

The Chairman remarked that all the committee desired to go into was the general question, not details.

Lord Thring: Have you examined these schemes on behalf of the Board of Trade?—Witness: I was told about them on Tuesday, and have given as much time to the matter as I could.

Do you speak for the Board of Trade?—I appear as one of its officers.

Do not the Board send a report to each committee?—No; not on the merits of schemes.

Mr. Bolton: Have you considered the desirability or practicability of the tunnels to take the ordinary trains?—Witness: There would be no object in making them so large. There is only one of the six schemes—that of the Great Northern Railway—which it is desired to make of that size.

Would it be desirable to have the tubes so large?—It would not be pecuniarily advisable.

But we are here to consider public policy, not the pecuniary policy of the scheme.—Quite so.

Would it not tend to postpone the thing if we advised the use of the large tunnels?—It might.

Is it not desirable to have a system of communication between North and South London by trains?—Yes.

How is it to be done except by tunnels?—There is no other practicable way.

If these schemes were sanctioned, might it not prevent the use of big tunnels in course of time?—Possibly.

Have the Board of Trade considered the question?—Not that I am aware of.

Would it not be desirable for the Board of Trade to consider it, and give us their advice?—That is a question for the committee.

Do you think a larger scheme to be necessary?—Yes.

Major Hutchinson added that he knew the lines were intended for passengers and parcels only. It would be a great advantage to have the City's passenger traffic relieved. It would be very costly to construct an ordinary railroad through the City. He had always thought it was of consequence that there should be free intercourse, north and south, for the ordinary rolling stock of the country. If the present schemes were carried out, it might delay a large scheme being adopted in the future. The Hampstead and Great Northern lines might tend to delay any larger scheme.

Mr. Greathead, recalled, said he had not made an estimate, but thought that on the last occasion he stated that as a rule the average cost of these schemes would be about a third or half the cost of the Inner Circle Railway. The difference in the cost of making a line 11 feet 6 inches or 12 feet in diameter, and one 16 feet, would be about £100,000 per mile; but, in addition, there would have to be larger stations, and the fact that the tunnel was being carried beyond the line of the street would entail further expenditure. Lines at the proposed depth could not possibly make junctions with the ordinary railway. In some cases the tubes would be perhaps 70 or 80 feet

below the ordinary railways. It would be practically useless to make them the ordinary size, as they could never be used for that kind of traffic. He did not share in the view that the Hampstead and Charing Cross line would have the effect mentioned by Col. Hutchinson. They would take a traffic that would not be touched by the other line. It was intended to go north from King's Cross to St. Pancras. The cost of working by electricity would not be greater than by steam. The trains, which would run every two minutes, would each carry 360 persons. In 1863 a committee recommended that luggage should be taken round about, not through London, and that had been acted upon. He did not think it impossible to construct hydraulic lifts to raise trains from the lower to the higher levels, but did not think it would be a convenient or workable arrangement. As he had said, the extreme depth of the new lines would prevent junctions with ordinary railways.

Mr. H. CRIPPS, agent for the County Council, said the latter had decided not to oppose the schemes, but to recommend (1) that the sizes of the tunnels be sufficient for an interchange of traffic with existing lines. The council were in favour of the multiplication of the means of travel, but they thought the lines should be large enough for ordinary rolling stock. (2) Subject to other conditions, the proposed underground lines ought not to follow the lines of the streets, but go from point to point, as straight as possible. The Baker Street and Waterloo Road, for instance, was longer than necessary, because it followed the street line. The lines were so deep, there could be no harm in going under the houses. The County Council wished to preserve the streets from disturbance as much as they could; he admitted that the lines were for the convenience of the public; and no doubt it would be right to try to tap the traffic along the great routes. The companies would have to pay for any damage done by the works. In the case of the present line, however, very little property was purchased. Whether the companies ought to pay for the privilege of making the lines was a matter for a court of law. The County Council, in passing the resolutions on the subject, wished merely to be cautious; and they thought that, if the lines were authorised, they should be carried out of London, into the suburbs, so as to increase facilities for getting away from the city. Further, the council might wish to purchase. They therefore wished to be given the power to purchase, after the lapse of a certain period, as in the case of tramways, &c. That right should be reserved to them though they might not use it. There was an analogy between these and surface lines, as the traffic would be similar. It was omnibus traffic. It was true that the lines would be too deep to interfere with sewers. The County Council possessed the right to occupy the soil beneath the streets of London. That was why they wished to be given the power to purchase. If the lines went under public property the companies should pay for it, as other companies did.

Mr. BOLTON: It is intended to run three trains per day each way, at a penny inclusive, I believe, but the County Council ask for more.

WITNESS: The council desire every facility to be given to the working classes.

The CHAIRMAN: We cannot go into these details. It is going beyond our reference. We are not empowered to deal with the very important question of cheap trains.

Lord STRAFFORD: How far do the council wish the lines to be extended into the country.

WITNESS: I don't think there was any definite scheme. It was only a suggestion that the lines should go into the suburbs as far as possible. If the lines were taken in a straight course they would be less likely to interfere with works of the future.

The CHAIRMAN: What possible works?

WITNESS: It is difficult to say.

The CHAIRMAN: Do you contemplate the possibility of any public works of this class under ground?

WITNESS: The council's engineer will answer that question.

Mr. GATHORNE-HARDY: You are quite sure the council do not wish the lines to be straight for the purpose of making a precedent of taking private property without compensation?

WITNESS: It is the first time I have heard the suggestion. (Laughter.)

Mr. A. R. BINNIE, engineer to the County Council, said the proposed lines would not interfere with any sewer. He understood that the council wished the lines to be quite straight only from station to station. He thought the routes were in some cases very convenient. It was the opinion that goods traffic should be conducted not through, but round the city. A recommendation to this effect had been very well attended to, so that it was not now necessary to invade what was called the inner circle with such traffic. There were three different lines for it. It was not at all likely that a great line of communication from King's Cross to Waterloo would prove remunerative, as there would be parallel lines to compete with it. It was a question whether London could best be served by one great through line or by several lines. In the schemes before the committee there were three different sizes of tubes, 11 feet 6 inches, 12 feet, and 16 feet. He thought all should be of one size—16 feet—especially after the statement of Mr. Greathead that the additional cost would not exceed a sum of £100,000 a mile. They would then be connected with the ordinary existing lines. It would not be possible to work the deep underground tunnels with locomotives, or without electricity or cables of some kind. The County Council wished the lines to be made so that they could be extended in the future. The new lines would be of the ordinary gauge, and thus there would be no difficulty in running the carriages on to the main lines. There would be a special form of rolling stock, with no side doors but doors at the ends. The introduction of the broader gauge into these lines would necessitate a great outlay at the termini, for the purpose of giving room for manipulating rolling stock. The present electric railway was a great public convenience, and the County Council had no complaints to make about it. If the cost of these lines were much increased, it might defeat the object of the County Council in getting a better means of locomotion in the City. If the committee decided on anything with a view that it was for the public good, the council would not oppose it. The ordinary railway carriage could be worked with the same power as the lighter carriage, but it would be at a greater cost. The light rolling stock of these underground lines could, if necessary, be used also on the regular railways. The carriages would be of the same size as those on the ordinary lines. The larger tunnels were needed merely to allow for the swinging of doors. The proposed lines gave what the public wanted done, and would meet a public need. He was not competent to speak on the claim of the County Council to be allowed to purchase at the end of a certain period. He could not say why that claim was made. He did not anticipate any nuisance from any noise or vibration that could be caused by the lines. If there were any such nuisance the companies would, of course, be liable, like any one else in such a case. There should be a clause in the Bill to protect the public in this respect. He did not anticipate any nuisance of the kind. The present electric railway did not cause any vibration that he could detect on the surface. The County Council would be represented, he thought, before the Commons committee on the subject.

Mr. CHARLES HARRISON, chairman of the County Council Parliamentary Committee, said the committee should consider the schemes as experimental, and not concerning the present only, but the future of London. There was only one line of the kind at present, but it was too soon to decide as to its complete success or failure. They looked to the connection of the lines on the existing lines, and that the terminals should be out in the open, and not in the centre of the City. The tubes should be of a size to admit of taking in ordinary rolling stock. It was almost impossible to realise the suburban growth of the City, and the extension of means of traffic tended to increase that growth at the outside, and thus relieve the overcrowded parts. The council thought the tubes should all be 16 feet in diameter, so as to facilitate travelling. Electrical engineering was, as yet, quite in its infancy, and they must lay down a system that would meet future demands, and not merely the wants of to-day. The South London Electrical Railway was working, but the question whether it would go on he could not answer; the expense might be too great. If this experiment succeeded, it would make a demand for a great extension of such means of travelling, and they should be ready for that demand. The council wished to avoid anything in the nature of a useless experiment. He did not see why the ordinary traffic should not be run in the 16-feet tunnels; there would be no difficulty as to ventilation.

Mr. GATHORNE HARDY: Have you not heard from the engineer that an ordinary locomotive consumes as much air as 30,000 people?

Mr. HARRISON said he had not. It would be better to go in a straight line and under the houses, than under the streets only. It would shorten the lines considerably, and prevent interference with streets. If there was no actual damage done to property when going 50 or 60 feet underneath the surface, it would not be the same in point of compensation as where undermining was needed. The council were of the opinion that they should have the right of acquisition, by purchase, in a certain time, as in the case of tram and gas companies—for the public good. The council unfortunately did not possess any remunerative undertakings. The public authority had only the right of user in the old streets, but they owned the new streets which they had laid out, and of which they had obtained the freehold.

The committee then adjourned.

EVIDENCE OF EXPERTS.

The Joint Committee of the House of Lords and the House of Commons met again at the House of Lords on Monday, May 16th, Mr. Stansfeld being in the chair. The other members present were: Lord Lauderdale, Lord Kelvin, Lord Shute, and Lord Strafford; and Messrs. Whitmore, Gathorne Hardy, Bolton, and Story Maskelyne.

Mr. BOLTON suggested that Mr. Harrison, whom it was proposed to recall, should give a *resumé* of the County Council's objections to the proposed schemes.

Mr. HARRISON (Chairman of the Parliamentary Committee of the County Council) said he had prepared a memorandum on the subject, and would be prepared to produce it at the next meeting of the committee.

Mr. W. H. PREECE, F.R.S., electrician to the Post Office, said he had given his attention to the subject of electric railways for over 20 years. It was only 11 years since Messrs. Siemens constructed the first electric railway, which was in Berlin. The same firm also constructed a line of electric railway from Portrush to the Giant's Causeway, in the North of Ireland, which had worked satisfactorily ever since. In 1884, witness was very much occupied in the working out of some experiments which culminated in the Blackpool Electric Railway, and he visited the U.S. in that year. At that time there was only one electric railway in existence, and that was at Cleveland (Ohio). Now there were two great electric railways in Cleveland—one with 71 coaches and another with 50. That was the whole of their rolling stock. He would place before the committee the enormous growth of the electric railway system. In 1884, there was but one such railway; in 1885, the number had increased to 3; in 1886, to 5; in 1887, to 7; in 1888, to 32; in 1892, to 436 railroads with 5,851 motor cars. In the U.S. the system was very popular, and was growing rapidly. It had now a tract mileage there of 3,532, with 5,851 motor cars. The total horse-power up to date in the U.S. was 87,700 (on the electric lines). Last year there were 250,000,000 passengers carried, the number of miles run being over 50,000,000, while the capital invested was £12,000,000—price per mile, £3,400. There had been no death in the U.S. caused on the electric railways, but in the same period (since 1884) there had been 5,241 deaths on the steam railroads alone. This great advance in electricity in the U.S. was due to the great in-

terest shown in the science, and to the demand for suburban tramways. There were no restrictions to contend against, and engineers, being eminently practical, when it paid to do so, disregarded all æsthetic considerations. (A laugh.) As to overhead wires, they thought them a sign of civilisation and progress. The electric railways of the U.S. were thus a great financial success. The Bradford Corporation, Yorks, had constructed a line of about 500 yards in length, for which they spoke of obtaining power from a central station. At Brighton there was a short line on the beach, but it was only a sort of toy. Many kinds of conductors were being tried. He had seen different railroads at work in Rome, Paris, Florence, Antwerp, Vienna, Brussels, Wolverhampton, and other places. There was not one tube railway in the United States. The six schemes the committee were now inquiring into were all tube railways. The only electrical tube railway in existence was the City and South London. As to the relative advantages of electric over steam railroads, they were enormous. In Boston, Mass., as in N.Y., the electric system was rapidly growing. The reasons for working railways by electricity instead of steam were:—(1) Electricity was more economical. (2) The starting and stopping were easier, and the train could be brought to a stand much quicker. (3) The power could be concentrated and centralised, and placed where it would produce the least possible amount of inconvenience. Further, it could be applied just where it was wanted for the traffic. With the fixed station, placed in a particular spot, the power could be used economically, and the line worked in the cheapest way. (4) There was no fear of explosion. (5) The electric motor was more controllable than the steam locomotive. With horses and cables it was difficult to make up for time lost, with electricity it was easy. (6) The air in the tunnels was not in any way vitiated by the electric trains—it was not poisoned by gas or by the refuse products of coal. There was no smell, no smoke, and the conditions in the tunnel were most favourable for the maintenance of the electrical connection, as neither rain nor snow could enter to interfere. In fact, continued Mr. Preece, the tunnel is an ideal place for an electric railway. The electric developments and successes of the present are the result of past failures. The same was the case with submarine cables, the same with telegraphy.

The Chairman: Can you tell us what the relative cost of the systems is?

Mr. Preece: In America the cost per car mile averages 6d. A car, in general, when full, would weigh 10 tons, and the number of passengers on the railroads I am referring to would be about 40 per car. The cars in the States are 16ft. and 25ft. in length, carrying 40 and 70 respectively. The cost of hauling the full car per mile is only 6d.

Lord Strafford: What would be the effect in case of a breakdown between the stations?

Witness: You could get out at the end of the car and walk to the station. The block system is in use. As a rule the trains have two motors, and the failure is due to the failure of one of the motors; and when one fails the other takes the train back more slowly. The South London line has been working for months with no failure at all. Trains have been delayed there, perhaps, from the failure of motors. In the early days the armatures of the motors failed; but I think the line is now working with much satisfaction. There has been no serious failure there at all. All the railways in America are of the ordinary gauge—4½ feet. In the United States the motor is usually on the car; they are called motor-cars. The motor-car weighs about 10 tons; the passenger car 7 tons. Each car has two motors of 15 H.P. each. The motor is separate from the cars in the South London Railway. The gradients in the English electrical railways are nothing to what they are on the American lines. One in 13 is the gradient in the electric railway at Chattanooga. We have nothing like that in this country. The great trouble in working an electrical railway is the amount of power required for the start. The starting on ordinary horse railways is one of the great reasons why horses fail so much. We have not yet experienced any trouble from electrical disturbance from the South London Railway, but there is a disturbance from it, and it is felt at Greenwich Observatory, and, indeed, all over the London district. It does not interfere with the working of our lines in the least. I am afraid the loss of power on the South London Railway is considerable, but I have not made any measurements. If it were possible to make an electric railway with a complete metallic circuit, there would be no disturbance. The South London Railway had done all in their power to decrease the disturbance, but cannot; but as it does not interfere with our working, we don't care much about it. In Leeds there is a similar disturbance, but it does not interfere with the working of the telegraph lines. The telephone company there complain, however. In the Post Office, where most of our offices are, we have two large engine rooms, with four great engines of 600 H.P. each, both of which are running continuously, but there is no vibration from them. At St. Martin's-le-Grand there are engines of 1,000 H.P., used for electric lighting, and there is so little noise and vibration, that in the next room you could not tell they were there, so that I do not anticipate any annoyance on the new lines from noise or vibration. If there were any disturbance it could very easily be remedied. There is only steam to be seen from electric railway works, but the British public have not yet learned to distinguish smoke from steam. It seems that the tubes now proposed to be made are ample for all purposes. The railways are intended for the use of urban passengers, not for luggage, generally. The schemes are designed to carry large numbers of passengers in a short time, and they work out very well. It is possible for the South London Railway to work 17 hours per day at a minimum of cost. Whatever a steam locomotive can do an electrical locomotive can do exactly the same. I have not inspected the workings of the South London Railway. There is not any difficulty in making an electrical railway quite safe. There would be only one train between two blocked stations. I do not see any advantage in having all the tubes of one size, each line being separate. As a matter of wisdom and judgment, of course it would be better to have all the tubes of one size. No one train follows another on the same section—that would be the system on all these new lines. It could be easily procured, even by automatic means. The joints in the tubes would, I believe, be watertight.

Mr. Alex. Siemens said he understood that the line to form a junction with the Northern Railway was not to be made by the latter, though it was promoted by them. On the South London Line the trains were about 30 tons, while those on the Northern would be 180 tons. It would be easy to make electric locomotives of the necessary weight and power to pull the 180 ton trains. The weight of the trains would cause no difficulty if the motor was sufficient to move it. From Finsbury Park to the City trains could be run at a cost of between 10d. and 1s. per train mile. On the City and South London line, with 30 ton trains, the cost is about 7d. per train mile. It would cost about £120,000 to make about 20 locomotives to work the Inner Circle Railway, as at present, the cost of working afterwards would be a little less than at present. Electricity is as easily applicable to heavy trains as steam, but it would not pay to run heavy trains by electricity unless they were frequent. If there were only two or three heavy trains per day, or per hour, it would not pay to put down the heavy plant. I don't see any difference in the steam and electric trains in the matter of practicability, but the oftener you have to run your electric trains, the better it would pay. To run short light trains would be better and cheaper by electricity than by steam; the electric trains would be more under control. Automatic block signals are used on the Liverpool line. I think the tubes should be small, simply on account of the cost. It would be better to have all the tubes of one size, though there would be no possibility of connecting them. At present the same pressure is contemplated on the new lines as is used on the South London, but I think 1,000 volts would be preferable to 500, considering the greater length of the railways. In case of any accident the section would be cut off from the circuit to allow the passengers to walk through to the station. If a man fell off on to the line it would not matter to him whether 500 or 1,000 volts passed through him—it would be all the same. (Laughter.) It might be safer to have the power placed overhead, but it would be more costly. It would not be a good arrangement, because passengers would not be allowed to walk in the tunnel. All who were permitted to go into the tunnel would know what they were about. It is a very convenient arrangement to place the conductor between the rails. It would be a good arrangement to place the conductor, if 1,000 volts, overhead, and if 500 volts underneath and between the rails. I think some men are much more liable to injury from electricity than others. The motive power would be attached to each train individually. In case of accident it would be very easy for the conductor to keep the people in till he cut off the current, the doors being at the ends of the carriages.

Mr. Greathead: The Board of Trade now allow us 500 volts, which is what we use on the South London line. The proposed carriages have convex tops, and they fit the tubes very well.

Mr. Chas. Scother, manager of the London and South-Western Railway, said the question of giving a cheap, convenient, certain, and safe communication between Waterloo and different parts of London had been under consideration over and over again. He had come to the conclusion that there were only three ways of dealing with the problem—(1) by taking the traffic through the streets; (2) by taking it overhead; or (3) by taking it underground. He preferred the underground plan, as the other two plans could not be tolerated. Out of a thousand million passengers carried on the British railways last year, only five were killed, which showed that the railway train was about the safest place to be in. He thought the convenience of the public would be met by an underground railway from Waterloo to the City, and from Waterloo to Baker Street. He dissented from the view that it would be a public convenience if these new lines were made so as to form junctions with the ordinary railways. It was impracticable, and they were intended to deal with a different class of passengers altogether. Omnibus traffic only would be dealt with by the new lines, and they would not interfere in the least with the business of the regular railways. We should require a very large space in the centre of the City to deal with them. By forming a junction with these lines and uniting it, you would be destroying the very essence of their value. The object is to deal with omnibus traffic only. All the London stations are congested, and what is wanted is something new to cope with the enormous traffic. There are junctions, made at vast cost, but which are not used, as it is not practicable to use them. The object was to get people into the City quickly. These new lines are merely an instalment of what is intended. The Metropolitan are contemplating the making of a fresh line at much less cost than the present one. The lines would not interfere at all with the traffic of persons going about with luggage—they are for omnibus traffic only.

Mr. W. N. Colam said it was proposed to work the Hampstead line by cable, which would run at 16 miles an hour to give an average speed of little better than that on the Metropolitan Railway and the New York overhead railways. The cable line over the Brooklyn Bridge had carried as many as 137,000 an hour—between five and six at night. The trains on the bridge weighed about 72 tons each, and the average speed attained was 10 miles an hour; the structure of the suspension bridge would not allow of a greater speed. On the elevated railways in New York the average cost was 12·6 pence per train mile. In this country it was much less. Cables very seldom broke, and when they did the delay was not great. A cable could be repaired or renewed in about an hour. Sharp curves were damaging to the life of cables; the curves on the present proposed lines were only trifling. There was no difficulty from heating when gripping the rope, and no sparks fly from the rope at such times. The rate of speed possible was anything below that of the cable. The tunnel from Charing Cross to Hampstead would be 4½ miles in length. The

conditions where the cable would give the best results were not the same as where electricity would do so. In the United States the opinion was that the present results were not so good as was expected in the future. In Broadway and Third Avenue, New York, they were making new cable railroads. In the South London electric line the cost of motive power was about 8d. per train mile run, each train weighing, when loaded, about 40 tons. In Chicago, the working cost of the cable lines was 1¼d. per train mile run. The more frequently the cable trains were run, the cheaper they would be. He would run light, and not heavy trains, so as to give a more rapid service.

The committee adjourned till the following Wednesday.

LEGAL.

The Western Counties and South Wales Telephone Exchange Company v. Bournemouth and District Electric Supply Company.—Chancery Division, May 13th, before Mr. Justice Chitty.—This matter came on before his Lordship in the form of a motion asking that a writ of sequestration directed against the Bournemouth and District Electric Supply Company for disobeying an order of the Court dated April 8th last, restraining them from working their electric lighting system in such a manner as to injure or interfere with the plaintiff's telephone system.

Mr. FARWELL, Q.C., who appeared in support of the motion said this was a most important matter to his clients as they could not work their telephones in a proper manner after the defendants turned on their electric current.

Mr. BYRNE, Q.C., for the defendants, asked that the motion should stand over for a week, he was not in a position to say anything about the matter just then.

Mr. FARWELL said the telephones were absolutely useless and he asked that defendants should give an undertaking not to use their electric light until next week. The days were getting longer and it would not be much needed now.

Mr. BYRNE said the defendants had been instructed to put their wires underground.

Mr. FARWELL thought this was a case in which one of the two companies must suffer the inconvenience of having their system practically suspended. On April 8th the defendants were ordered to put the wires underground and they had done so, but the nuisance was now worse than before, and he submitted this was not a case in which the plaintiff company should suffer the inconvenience.

Mr. BYRNE said it was absurd to ask them to stop the working of the system for a week as the light was in daily use. They had, however, sent down their engineer to see what could be done.

Mr. FARWELL wished to point out that the system was not used to light the town, but only private buildings, and consulting the convenience of the people of Bournemouth the proper working of the telephones was much more important. If, however, the defendants would not agree to stop the working of their system for a week he asked that they should not start the electric current until eight o'clock at night. He would suggest that Major Cardew, of the Board of Trade, should go down to Bournemouth to see what was being done.

Mr. BYRNE said he was unable to give any undertaking.

Mr. JUSTICE CHITTY did not see his way to insist upon any undertaking, and he directed the motion to stand over for a week.

Electric Arms and Ammunition Supply Syndicate.—On Monday, in the Queen's Bench Division, before Mr. Justice Grantham and a common jury, the case of the Electric &c. Supply Company *v.* Peo.le, came on for hearing. This was an action to recover a sum of money in respect of calls on shares in the above named company. The defendent alleged fraud and misrepresentation, and counterclaimed for a rescission of contract. For the plaintiff, it was stated that the defendant took some shares in the company, but declined to pay the calls due on them, on the ground that a statement that the arrangement was evidently suitable for its purpose was untrue.

For the defence the defendant, Mr. Peole was called by Mr. Jelf, Q.C. He said that he took the shares on the faith of the statement in the prospectus that the company had a battery absolutely perfect and suitable for the purpose. He thought this statement was made recklessly, in view of the explosion which occurred.

The jury stopped the case at the conclusion of defendant's evidence. They said they found that the prospectus was issued in good faith, and that the directors thoroughly believed in the statements in it. The charge of fraud failed, as there was no material misstatement in the prospectus.

Mr. JUSTICE GRANTHAM, in giving judgment for the plaintiffs for the amount claimed, said there was not a tittle of evidence to support the charge of fraud which had been made, that these gentlemen got up this company for the purpose of putting money into their own pockets. Judgment for the plaintiffs on the claim and counter-claim with costs.

Love v. St. James's and Pall Mall Electric Light Company, Limited.—In the Chancery Division of the High Court of Justice on Saturday, Mr. Justice Stirling gave his ultimate decision upon the motion in the action Love against St. James's and Pall Mall Electric Light Company, Limited. The plaintiff was represented by Mr. Hastings, Q.C., and Mr. E. S. Ford; and the defendant company by Mr. Buckley, Q.C., and Mr. Medlow. The motion was to restrain the defendants from building their new central station in Carnabee Street in such a manner as to interfere with the plaintiff's rights of light and air; and, as already reported in these columns, the plaintiffs having modified their plans and undertaken not to build in such a way as to interfere with the plaintiff's light, the only question remaining for his Lordship to consider was the question of costs. In giving judgment,

HIS LORDSHIP said that the defendants' architect all along asserted that the plaintiff was mistaken in supposing that the height of the old buildings was only 37 feet 5 inches, and that their true height was 39 feet 6 inches. That matter had been in issue between the plaintiff and the defendants, through their architect and agent, from the 18th of March, and during the rest of that month, the defendants failed to convince themselves that in respect of that height, the plaintiff was in the right, as he ultimately proved to be. It was nowhere to be inferred from the correspondence, that the defendants were not inclined to arrange their plans on the footing that the true height of the buildings they had removed was 39 feet 6 inches, instead of, as was now admitted, 37 feet 5 inches. His Lordship thought that under those circumstances the plaintiff was justified in bringing his action; and the question was, ought he to treat the plaintiff as having been so unreasonable that he ought to deprive him of his costs? His Lordship thought not. He thought that the plaintiff had reasonable grounds for bringing his action in the first instance, by reason of the defendants' architect down to the date on which the action was brought, persisting in his erroneous view as to the height of the old buildings. His Lordship accordingly held that the costs of the motion must be borne by the defendants.

NOTES.

Crystal Palace Exhibition.—We understand that at a meeting of the exhibitors held at the Crystal Palace on Saturday last the chairman stated that so far as the directors of the Crystal Palace Company were concerned, they would like the exhibition to remain open until the middle of September. Mr. Crompton said he had consulted several of the exhibitors and he had come to the conclusion that July 2nd was as late a date as it was desirable for the exhibition to remain open. Other gentlemen having spoken for the earlier and the later date, a vote was taken, when 50 voted for July 2nd and 42 for September 15th. The chairman thought that as the voting showed the meeting to be so evenly divided it might be desirable to suspend decision on the matter for a week, and in the meantime to issue a circular to all the exhibitors with a view to ascertain their opinions, the meeting being adjourned to to-morrow when the date of closing will be announced. We have every reason to believe that the prominent exhibitors are so much in favour of the earlier date that it is most likely to be resolved upon, even if it becomes necessary for some of the exhibitors to decline to be bound by the majority.

New Candidate for Parliamentary Honours.—Mr. Thomas Parker has accepted the invitation of the electors to become the liberal candidate for the Kingswinford division of Staffordshire. His address to the electors together with his portrait and a short sketch of his career is being circulated. It is not, perhaps, generally known, that but for Mr. Parker the electrical trades would now have been in as chaotic a state as they were ten years ago, yet, quoting from his biography, "Mr. Preece, speaking before the Society of Arts somewhere about this period (1885) said that the revival of the electrical industry was due to the efforts and success of Mr. Parker." Truly electioneering pamphlets are as fearfully and wonderfully made as electrical engineering specifications.

Postal Reforms and Telephonic Communication.—A numerous deputation from the Associated Chambers of Commerce, accompanied by many members of Parliament, had an interview in the Conference-room of the House of Commons last Friday evening with Sir James Fergusson, the Postmaster-General, to urge a variety of postal reforms, the better protection of telegraph wires, and the acquirement of the telephonic system by the Government. In reply, the Postmaster-General said that as to the better protection of telegraph wires, these wires were now underground in most urban centres, but that resulted in considerable loss of power, which meant diminution of efficiency and increase of expense if the same system was made general. As to the Government management and control of telephones, the experience of the United States showed that efficiency and success were not dependent upon that condition, but the increased general powers about to be sought in a Bill by the Government would doubtless lead to an improvement of the telephonic service.

Glossop Lighting.—The question of lighting the streets with the electric light was introduced at the last meeting of the Glossop Town Council and deferred for consideration.

The Electric Light in Tasmania.—The company which has been formed to operate electric tramways in the town of Hobart, Tasmania, intend to ask Parliament for power to light the town of Hobart by electricity.

O.S.A.—The last smoking concert of the season will take place on Friday, May 27th, at Mason's Hall Tavern, Basinghall Street, E.C., at 7.30 p.m. An excellent programme has been provided, including the names of Mr. T. H. Harrison, Mr. Trefelyn David, and Mr. W. G. Bryant (violin).

Weaving by Electricity at Blackburn.—A Blackburn paper states that the experiment of weaving by electricity was last week tried with perfect success at the loomworks of Mr. Henry Livesey, Limited, Greenbank, Blackburn. The works are illuminated by electric light.

Obituary.—In our last issue we recorded the death of Prof. James Thomson (brother of Lord Kelvin), and we now deeply regret having to announce the decease of the wife and second daughter of the late professor. On Sunday 8th inst. the professor expired, on Wednesday 11th the second daughter died, and on Sunday 15th inst., Mrs. Thomson's death took place.

S.S. "Westmeath."—We are informed that this telegraph steamer has been purchased by the Société Générale des Téléphones, and is renamed the *François Arago*. She is at present at Havre, undergoing extensive alterations before sailing to the Mediterranean for the laying of the Marseilles-Oran cable, the contract for which was recently secured by the above-named company from the French Government.

Bazaar Attractions.—At a bazaar held during four days of last week at the South London Institute of Music, the National Telephone Company very kindly provided, free of charge, a series of telephonic entertainments, consisting mainly of reproductions of comic operas from the London theatres. Mr. Weymersch also generously fitted up an exhibition of electric lighting in connection with his well-known primary batteries. Other electrical attractions would have doubtless been added had space and time permitted.

Accident to a Cable Steamer.—A Lloyd's telegram, dated May 13th, off Chuy, states that the *Norseman*, Western and Brazilian Telegraph Company's (Limited) steamer experienced a heavy gale on the 10th and sprung a leak, which put out the fires. All the pumps got choked, and the crew were engaged all day and night baling with buckets, but the water gained. The weather moderated on the 12th, and during the night all hands were transferred to the *Scotia*. When left, the *Norseman* had 11 feet of water in the engine room and 3 feet 6 inches in the after hold. Should the bulkhead hold, the *Scotia* will attempt to tow her to Montevideo. A later telegram, dated May 13th, 8 p.m., off Chuy, states that an attempt would be made the next day to tow the *Norseman* which was in a dangerous condition and position.

Electric Lighting in Manchester.—Mr. Samuel Joseph Smith, one of the inspectors of the Local Government Board, held on Tuesday last, in the Mayor's Parlour at the Town Hall, an enquiry into the application of the Town Council to borrow the sum of £150,000 for purposes of electric lighting. Sir John Harwood, who was called upon to give evidence, said the Corporation had had the question of electric lighting under consideration for the last ten years at least. The contracts which had been already let, and others which would be let shortly, amounted to £78,000. Already enquiries for the light had been received from persons outside the compulsory area. If the circumstances and the probable consumption made it appear desirable, the Corporation would extend the area and give every facility they possibly could to induce people to use the light. Of course, they were not seeking to make a profit out of the scheme in any way. They were only seeking to develop the resources of the city. At the close of the enquiry the inspector visited the site of the generating station.

The Electric Light in China.—The authorities of the town of Haiphong, China, are studying the question of introducing the electric light.

Electric Lighting Station for Dundee.—The report of Prof. Kennedy, London, on the electrical station for Dundee, has been received, and is now in the printer's hands. A special meeting of the Gas Commission was held last Tuesday, when the report was considered. It is understood that matters will soon be in such a forward state that the Commission will be in a position to advertise for tenders.

Exeter and the Electric Light.—The City Council, at a special meeting on Wednesday last, considered the report of their surveyor, Mr. Donald Cameron, on the proposed substitution of electric light for gas in the public streets of the city. He states: "The cost of the electric lighting throughout the whole area is about double that of the present gas lighting, but there is no comparison between the efficiency of the two lights. Whether the streets are lighted by gas or electricity, there is evidently a demand for more light."

Accumulator Cars for Berlin.—Some time ago, at a meeting of the Grosse Berliner Pferde-Eisenbahn Gesellshaft, it was stated that the company proposed to adopt electricity as the motive power. After thorough investigation, the company declares its willingness to introduce accumulator cars experimentally on the new line which is to be completed this summer. The company considers the self-contained system to be the most simple and suitable for dealing with the traffic in cities. The company is also prepared to experiment with an underground system, similar, for instance, to that at Buda-Pesth, and for this purpose permission has been asked of the chief magistrate for the construction of a line from the Reichenberger Strasse to the Zoological Gardens.

Immense Submarine Cables.—The *Electrical Review* of New York, for May 7th, contains an article headed "Submarine Cables," which gives an account of an "immense" cable recently laid by the tug, *Western Union*, across the entire width of the Hudson river, from the foot of Vesey Street, New York, to the foot of Morgan Street, Jersey City. This cable is described as "submarine armoured," and contains 18 conductors. Its length is no less than 5,300 feet, and the work of laying it occupied eight minutes of time. The same article contains a quotation from a recent issue of the New York *Sun*, which is as follows:—"An ocean going steamship, in leaving her dock at Jersey City, plowed up the soft bottom with her powerful propeller, and secured a costly and valuable catch in the shape of about a dozen submarine cables." This is immense, indeed!

The Edison Incandescent Lamp Litigation.—More than 12 years after the issue of Edison's fundamental patent, and seven years almost to a day, after the commencement of legal proceedings by the Edison Electric Light Company against the United States Electric Lighting Company, the beginning of the end in the long-protracted incandescent lamp litigation has been reached. The case, says the New York *Electrical Engineer*, having been decided in the Circuit Court in favour of the Edison Company, the United States Company carried the case to the Circuit Court of Appeals, which tribunal now has final jurisdiction in all patent cases, and, after eight days of argument by the ablest counsel of the land, the case goes to Justices Lacombe and Shipman for final decision. Summed up in brief, the contention of the complainant is, that to Edison the world is indebted for the art of incandescent electric lighting, and that the most essential instrumentality of the art, the high-resistance carbon lamp, is covered by the patent sued upon. The contention of the complainant, on the contrary, is that whatever Edison may have invented, the particular patent sued on neither describes nor covers the invention in controversy, and moreover, that the complainant, having delayed for many years to commence suit, during which time the defendant had invested large amounts of money in the business, should at least be required by the Court to permit the defendant to continue the manufacture of lamps upon the payment of a reasonable royalty.

The Royal Society.—The following papers were down for reading before this Society last night:—S. Bidwell, F.R.S., "On the Changes produced by Magnetism in the Length of Iron and other Wires carrying Currents." T. Gray, "On the Measurement of the Magnetic Properties of Iron."

Electric Lighting for Aberdeen.—Prof. Kennedy, visited Aberdeen on Saturday last with the view of reporting to the Town Council as to the introduction of a system of electricity into the city. He expressed the opinion that the installation should be in the hands of the Corporation, and not under the control of a private company.

Royal Society.—New Candidates.—The following candidates were, amongst others, selected on May 5th by the council of the Royal Society to be recommended for election into the Society. The ballot will take place on June 2nd:—R. Y. Armstrong, Lieut.-Colonel, R.E.; J. A. Fleming, M.A. (Camb.); Joseph Larmor, M.A., D.Sc.; and Augustus D. Waller, M.D. The remaining eleven selected fellows are not identified with electrical science.

An Electric Railway for Siam.—The New York *Electrical Engineer* states that the entire installation for the first electric tramway in Siam is being shipped by the Short Electric Railway Company. The plant goes to the Bangkok Tramways Company, who will equip a road 6 miles long, 6 foot gauge. The plant includes two generators, two steam plants complete, six car equipments and extra parts to last for six months.

The French Cable Telegraph Company's New Cable.—The joint resolution granting to the French Cable Telegraph Company, of Paris and New York, the right to land a cable on the shores of Virginia and South Carolina, thence to go from Cuba to San Domingo, was, says the New York *Electrical Engineer*, the subject of a hearing recently before the Senate Committee on Commerce, at which Secretary Blaine, members of the French Legation in Washington, and attorneys for the company were heard. Secretary Blaine made a vigorous protest against the passage of the resolution, urging that it should be killed in committee. It would, he said, prevent the growth of an American cable system to Brazil.

High Tensions and High Frequencies.—We print elsewhere an abridged translation of an article by M. E. Hospitalier on the future of high tension electrical transmission of power. The views, although roughly expressed, are valuable in connection with the nonsense that has been said and written about high frequencies and high tension currents. The qualitative experiments of Tesla, Elihu Thomson, Swinburne and Siemens Brothers have somewhat unsettled things, and the New York *Electrical World* has not improved matters by the four questions which they sent to various authorities, "eminent and otherwise," to quote our esteemed contemporary, the *Electrician*. We have reprinted the questions and also the replies of the more eminent electricians. The whole forms very instructive reading, and is well suited to second year students.

Protection of Single Wire Telephone Lines against Induction.—A paper on this subject was recently read by M. Dobrowolsky. The author endeavours to accomplish the object in view by placing an adjustable secondary coil of an induction coil in circuit with the telephone wire, the primary coil or coils being inserted in the wire or wires which are in the proximity of the telephone circuit and in which they cause the disturbances. By this arrangement the induced currents set up by the induction coils are supposed to counteract those set up by the parallelism of the lines. We know from actual experience that this can be successfully accomplished in a laboratory, but, as a matter of fact when the idea is applied in practice it fails, because no account is taken of the static effects caused by the lines having inductive capacity; this latter can possibly be approximately balanced but the complication of artificial lines which would be necessary for the purpose render the arrangement practically of little or no value. It would, in fact, be cheaper to provide a second wire and cure the disturbance by working a metallic circuit.

Electric Light on Training Ships.—At last week's meeting of the School Board it was agreed that a sum not exceeding £1,500 be expended for the installation of the electric light, and certain small alterations on board the *Shaftesbury* training ship.

Another Execution by Electricity.—Another execution by electricity, as provided by the law of New York State, took place on Wednesday in Auburn Prison. A man named Tice, who murdered his wife, was executed, and the operation is said to be the most successful since electricity was employed. The voltage was 1,720. When the face was uncovered it showed the same appearance as in life. Death is believed to have resulted from the first contact.

A Photographic Study of Non-Arcing Metals.—Mr. A. J. Wurts, continuing some investigations on this subject, points out that all of the non-arcing metals so far experimented with have proved to be diamagnetic. He finds that the smaller the air gap between the electrodes the smaller is the arc, and that there is an apparently violent repulsion of the arc between non-arcing metal electrodes as compared with the evenly diffused arc between carbon electrodes.

Board of Trade Unit.—Mr. G. Binswanger writes to us as follows:—With reference to Lord Kelvin's letter in your last issue, regarding a more appropriate denomination for the Board of Trade unit, I wish to state, as one largely interested in the manufacture and sale of supply meters, that I consider the word "unit" as extremely misleading and likely to give rise to confusion, and further, with due apology to Lord Kelvin, that his suggestion to call it "supply unit" will not fully meet the objection. The word "unit" has a well-defined meaning in the English language. Why should we give it a second meaning necessarily at variance with the value it now expresses? All other values of electrical measurements have received short and appropriate expression, derived from names not otherwise used in any language. Why make an exception with the value of Kilowatt-Hour? As an instance of the misunderstanding arising out of the use of the word "unit," let me cite the following case. The meter dials are all divided into multiples of tens, not necessarily ranging from top to bottom, but sometimes arranged in circles or otherwise. This necessitates to clearly indicate in print the values from 1-10, 10-100, 100-1,000, and so on, and logically and grammatically correct it is to call the first units, the second tens, the third hundreds, and so forth. But as meters are generally calibrated to represent figures to be multiplied by constants, or as is mostly the case, each stroke on the dial denotes the ampere hour at 100 volts, or $\frac{1}{10}$th of a unit, it is clear that we shall lead consumers into confusion by printing on the first dial "units," whilst it really represents only $\frac{1}{10}$th of a Board of Trade unit. I could cite other instances which have come under my notice, all pointing to the desirability of expressing the value of a Board of Trade unit by some other word. It is not my province to suggest such a word, but it is no doubt most desirable that the expression chosen should be one likely to be accepted by all nationalities, and for this reason, I certainly am of opinion that no better word than "Kelvin" could have been suggested, a word short, easily pronounceable, and derived from the title of our greatest living scientist, whom every nation delights to honour.

Duelling Extraordinary.—M. Roulez, the inventor of a telephone transmitter well known in France, is the hero of an extraordinary series of encounters. A quarrel arising between himself and three other gentlemen during the first representation of *Salammbo* at the Paris Opera on Monday evening, it was arranged that on Wednesday morning last he should meet his three adversaries in the Bois de Boulogne one after the other. Although M. Roulez is over 50 years of age, he disposed of his three young antagonists in a very brief period, each of them receiving severe sword wounds. One of the seconds losing all patience at seeing his friends placed *hors de combat* in such rapid succession insulted the veteran swordsman, and a fourth duel being then and there arranged, he, too, fell a victim to the consummate skill in the art of fencing shown by his opponent. Probably in the whole history of duelling such a feat has never been equalled, if, indeed, approached. *Vive* M. Roulez.

Organisation of the New York General Electric Company.—The *Electrical Review*, of New York, states that the General Electric Company, which includes the Thomson-Houston Electric Company of Boston, and the Edison General Electric Company, of New York, has received its charter under the laws of the State of New York, and will be known hereafter as the General Electric Company.

"The Dream of Ferranti."—The *Western Electrician* criticises our recent leading article on this subject in the following becoming manner. It says :—"To an American with the Review's record of the corporation's business before him and a knowledge of what has been accomplished by young men on this side of the water, such attacks first cause wonderment and then disgust." . . . . "We hardly know what to think of the Review. Can it be that Mr. Ferranti incurred its displeasure by his bold and daring display of that characteristic so distinctly American, or can it be that our contemporary is 'grinding an axe,' in its philanthropic efforts to throw cold water, so to speak, on the enterprise in this its darkest hour." We would refer the *Western Electrician* to its American contemporary, the *Electrical Engineer*, whose editor appears to look at the matter in a way "quite English, you know."

The City and Guilds of London Institute.—The 12th Annual Report of the Council of this Institute shows that a steady progress is being made. In the Central Institution the number of students who presented themseves for matriculation was 99, and the number attending during the winter term 177. Amongst the additions to the laboratories and workshops were a new Babcock and Wilcox boiler, for experimental purposes, a complete set of Thomson-Houston constant current apparatus, including three arc lamps, &c., a shunt-wound dynamo, and an electro-depositing plant. The amount received in student's fees was £4,086, against £3,772 in 1890. In the City and Guilds Technical College, Finsbury, the number of day students was 197, against 185 in the previous session. During the 8th complete Session of the College, 48 students attended the Mechanical Department, 99 the Electrical, and 38 the Chemical. In the Evening Department the Elementary Course of Electric Technology was attended by 196 students, against 125 in the previous Session. In the evening classes the entries during the current Session, up to February 20th, 1892, have been as follows :—Mechanical Department, 244 ; Electrical Department, 617 ; Chemical Department, 99 ; Applied Art Department, 120 ; Trade Classes Department, 160. As regards the Technological Examinations, the number of candidates (those entering for more than one subject being counted accordingly) was 7,416, against 6,781 in 1890, and of these 400 more succeeded in passing than was the case in the previous year. The total number representing Electrical Technology in all its branches, was 631 ; the highest number in other trades being in "Spinning," in which subject 1,116 candidates entered ; Carpentry and Joinery, Weaving, Mechanical Engineering, and Plumbers' work follow with the respective numbers—837, 702, 739, and 684. The total income of the Institute was £30,940.

Telephonic Evidence.—The *Daily News* states that a Berlin manufacturer has received the following interesting letter from a St. Petersburg firm : "It is intended to introduce into some of the prisons here microphones for the purpose of eavesdropping on the prisoners. I beg you to inform me by return of post whether you have manufactured such microphones, or whether you would be willing to do so. It is intended to fix them in the wall or the floor, and they must be so sensitive that, when covered on the outside with wall-paper, they may repeat everything spoken by a person in any part of the room. Something of the sort exists already, and I should like to make use of the microphones manufactured by you, but that they would have to be altered a little for the purpose." The Social Democratic organ, *Vorwärts*, which publishes the above statement, adds that the German firm has already sent a sample microphone to St. Petersburg, and that the experiments made with it were very successful. The paper expresses the suspicion that these microphones are particularly destined for political prisoners, and publishes the letter as a general warning.

Electric Lighting at Nelson.—At the Nelson Town Hall on Tuesday last, a Local Government Board enquiry was held regarding an application of the Corporation to borrow £10,000 for electric light purposes. The chairman of the Gas Committee said they proposed to work the electric light scheme from the gasworks. A 60 horse-power steam engine would be used, and they would put down one 600 incandescent light dynamo. The Council had entered into an agreement with a number of tradesmen for 482 lights to be supplied for three years.

Distribution at High or Low Pressure.—At first sight, the figures given in the recently issued balance-sheet of the Metropolitan Electric Supply Company concerning the generating expenses in the stations appear to be a strong argument against the use of high pressure, since they are very high as compared with those of the St. James and Pall Mall Company, which may be taken as the best representative of the low pressure systems. The cost per unit delivered for coal, water, oil, &c., appears to come out at about 2½d. for the Metropolitan Company as against 1¼d. for the St. James, or just double, whilst the salaries and wages amount to nearly 1⅛d. for the former, against ⅛d. for the latter. The explanation, no doubt, is to be found in the losses in the transformers, which, with the present system of placing them in the houses, must be very heavy on account of the low load factor ; and also in the fact that there are four stations working, which in the aggregate are capable of giving sufficient output for about 250,000 lamps, whilst the actual lamp connections at the end of the year were only 82,000, and the average during the year about 65,000. If this latter figure is adopted as a basis of calculation, it appears that each lamp is burnt between 600 and 700 hours per annum, whilst the transformer losses are going on steadily all the time, so that it may be said, roughly, that the conditions are equivalent to the following : for 8,000 hours the transformers are working on open circuit, and for, say, 700 hours on full load. Although a comparison of generating costs is decidedly unfavourable to the high pressure system, there are other points to be considered ; and in some of these, such as the outlay on land and mains, the position is reversed, a point which will tell considerably as soon as the Metropolitan Company is working as nearly up to its full capacity as the St. James's and Pall Mall Company. The other great difference between the conditions of the two companies is that of the shape and extent of the areas which they supply, and it is this which in each case justifies the choice of systems made by them, as in a comparatively small and compact district like that of the St. James's Company, the heavier generating expenses of a high pressure system, even supposing them to be reduced to something much lower than those at present shown by the Metropolitan Company could not be counterbalanced by any adequate saving in the cost of mains, whilst in the larger and more straggling district served by the Metropolitan Company the cost of mains for a low pressure system would be so enormous that it is very doubtful if it would be possible to earn a dividend on the capital outlay that would be required.

NEW COMPANIES REGISTERED.

Bickle and Company, Limited.—Capital £50,000 in £10 shares. Objects : To acquire, take over as a going concern and carry on the business of mechanical engineers, tool makers, boiler makers, brass founders, &c., carried on under the style of Bickle and Co., and to carry on the business of electrical contractors, electrical engineers, electricians, suppliers of electricity for the purposes of light, power and heat, and manufacturers of electrical apparatus. Signatories (with one share each) T. E. Bickle, 27, Durnford Street, Stonehouse, Plymouth ; J. Bickle, Compton Park, Plymouth ; G. H. Ellery, 1A, Boon Place, Plymouth ; J. Polmear, 18, Union Street, Stonehouse ; W. R. Ralph, 11, Durnford Street, Stonehouse ; J. Werry, 15, Sweet Home Terrace, Plymouth ; W. J. Winman, 11, Durnford Street, Stonehouse. The number of directors is not to be less than three nor more than seven, the first to be appointed by the sub-

scribers. Qualification, 20 shares; remuneration as the company in general meeting may determine. Registered on the 13th inst. by Waterlow Bros. and Layton, Limited, Birchin Lane, E.C.

London and Hampstead Battery Company, Limited.—Capital, £50,000 in £5 shares. Objects: To acquire as a going concern the business of electrician and otherwise carried on by Mr. A. W. Armstrong at Finchley Road, and in the parish of St. John's, Hampstead; to accept a proposal made in writing by Mr. A. W. Armstrong; and to carry on in the parish of St. John's, Hampstead, and elsewhere, the business of an electric lighting company, and also that of electricians, mechanical and electrical engineers, and manufacturers of electrical apparatus. Signatories (with 1 share each): H. J. Peachey, 32, Craven Street, W.C.; W. E. Ruck, 31, Craven Street, W.C.; M. Hallett, 7, St. Martin's Place, W.C.; R. G. Fuller, 7, St. Martin's Place, W.C.; J. Hamilton, 157, West George Street, Glasgow; G. J. Rowley, 11, Candahar Road, Battersea; W. C. Hallett, 7, St. Martin's Place, W.C. The number of directors is not to be less than 3 nor more than 7; the first being W. C. Hallett, R. J. S. Beeton, and A. W. Armstrong. Qualification, £500; remuneration, £600 per annum, divisible. Registered on the 13th inst. by H. P. Spottiswoode, 32, Craven Street, Charing Cross, W.C.

R. C. Cutting, Douglass and Company, Limited.—Capital £20,000 in £5 shares. Objects: To acquire the goodwill, plant, trade marks and stock-in-trade, and to carry on the business of lightning conductor manufacturers and electrical engineers carried on under the style or firm of Messrs. R. C. Cutting, Douglass & Co., at Doctors' Commons, London, E.C. Signatories (with one share each): A. Douglass (electrical engineer), Wardrobe Chambers, E.C.; F. W. Heale, 84, Fleet Street, E.C.; W. G. Bundy, Wardrobe Chambers, E.C.; J. W. Kolckmann, Jun., 2, Langham Place, W.; F. W. Bundy, 20, Morden Grove, Lewisham; A. Lond, St. Margaret's Square, Brockley; H. G. Douglass, 71, Knatchbull Road, Camberwell, S.E. The number of directors is not to be less than three nor more than seven, the first being F. W. Heale, F. W. Bundy, A. McKeand, A. M. Cochrane and A. Douglass (managing director with £150 per annum). Registered on the 11th inst. by G. J. Baypool Porter, solicitor to the company, Wardrobe Chambers, Doctors' Commons, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electricity and Electrical Engineering Newspaper Company, Limited.—The statutory return of this company, made up to February 17th, 1891, and filed on March 1st, 1892, shows that out of a nominal capital of £500 in £10 shares, all the shares have been taken up, the full amount called, and all calls paid.

The first annual return, made up to February 29th last, was also filed March 1st, when all the shares were taken up. Registered office, 34, Cannon Street, E.C.

Electrical Works Construction and Maintenance Company, Limited.—The annual return of this company, made up to December 31st last, was filed on the 13th ult. The nominal capital is £2,000, in £1 shares, of which 7 have been taken up, and nothing called thereon. Registered office, 15, St. Helen's Place, E.C.

India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.—The annual return of this company, made up to March 8th, was filed on the 5th ult. The nominal capital is £812,000, in £10 shares. Of these 41,600 have been taken up, the full amounts called, and all calls paid.

Llanelly Electric Light and Power Company, Limited.—The annual return of this company, made up to February 9th, 1891, was filed on March 15th, 1892. The nominal capital of the company is £15,000, divided into 10 "A" and 14,990 "B" shares of £1 each. Of these, 7 "A" shares have been taken up, but no calls have been made. Registered office, New Dock, Llanelly.

Johannesburg Lighting Company, Limited (the supply of gas and electricity in Johannesburg). The statutory return of this company, made up to March 24th, 1892, was filed on March 30th. The company has a nominal capital of £150,000, divided into 100,000 ordinary and 50,000 preference shares of £1 each. 17,570 ordinary and 8,400 preference shares have been taken up, all of which have been given in exchange for debentures in the late South African Company.

Ward Electrical Car Company, Limited.—The annual return of this company, made up to January 13th, was filed on March 7th. The nominal capital is £300,000, in £10 shares, all of which have been issued as fully paid. Registered office, 38, Gracechurch Street, E.C.

Woking Electric Supply Company, Limited.—The annual return of this company, made up to November 19th, was filed on March 22nd. The nominal capital is £20,000, in £5 shares, of which 2,112 have been taken up, and 2,000 issued as fully paid. Upon the remaining shares 25s. per share has been called, and £85 has been paid, leaving £55 unpaid. An agreement of April 12th with the Electric Trust, Limited, determined that the Electric Trust should have 843 fully paid shares allotted to them in full consideration for work done and goods supplied. Office, Board School Road, Woking.

Willans and Robinson, Limited.—The annual return of this company, made up to the 20th ult., was filed on the 25th ult. The nominal capital is £200,000, in £50 shares, of which 2,200 have been taken up. Of these 980 have been issued as fully paid, and upon 1,213 shares the full amount has been called; upon one share £30 has been called, and upon six shares £20 per share has been called, resulting in the payment of £60,740, and leaving £60 unpaid. Registered office, the Ferry Works, Thames Ditton, Surrey.

Liverpool House-to-House Electricity Company, Limited.—The annual return of this company, made up to January 11th, 1892, was filed on the 30th ult. The nominal capital is £100,000 divided into 19,900 ordinary and 100 founders' shares of £5 each. Of these 7 ordinary and 100 founders' shares have been taken up, of which the founders' shares have been issued as fully paid to the House-to-House Electric Light Supply Company, Limited. Upon the seven ordinary shares no calls have been made. Registered office, 15, St. Helen's Place, London, E.C.

Phosphor Bronze Company, Limited.—The annual return of this company, made up to the 1st ult., was filed on the 21st ult. The nominal capital is £150,000, divided into 15,000 ordinary and 15,000 preference shares of £5 each; 7,335 ordinary and 8,375 preference shares have been taken up, the full amount called, and all calls paid; £90 has been paid on 18 ordinary and 18 preference shares forfeited. Registered office, 87, Sumner Street, Southwark, S.E.

Dick, Kerr and Company, Limited (manufacturers of the "Griffin" gas engines, railway contractors, and electrical and general engineers). The annual return of the above-named company, made up to the 12th ult., and filed on the 26th ult., shows that out of a capital of £160,000, divided into 16,000 ordinary and 16,000 preference shares of £5 each, all the shares have been taken up. Of these all the ordinary shares have been issued as fully paid to the vendors, and the full amounts have been called and paid on the preference shares. Registered office, 101, Leadenhall Street, London, E.C.

Southampton Electric Light and Power Company, Limited.—At extraordinary general meetings of this company, held at 23, High Street, Southampton, on March 28th and April 25th, 1892, a special resolution was passed and confirmed, for the purpose of changing the end of the financial year from June 30th, as fixed by the articles of association, to December 31st (filed on the 3rd inst.). Registered office, 23, High Street, Southampton.

Atlas Electric Appliances Company, Limited.—A general meeting of this company was held at 10, Coleman Street, E.C., on April 1st, 1892, to receive the final report of the winding up, but a letter from the liquidator (M. Lancaster, of 10, Coleman Street, E.C.), states that there was no quorum, and therefore no business done. Registered office, 206, St. George's Street, E.

Stanhope Company, Limited (Electrical and General Engineers).—The annual return of this company, made up January 13th, was filed on March 7th. The nominal capital is £30,000 in £5 shares, all of which have been taken up. Of these 2,000 have been issued as fully paid, whereas the full amounts have been called and paid on the remaining 4,000 shares. Registered office, 20, Bucklersbury, E.C.

BUSINESS NOTICES, &c.

Electrical Organ Blowing.—The magnificent new organ built by Messrs. Abbott & Smith, Blackman Lane, Leeds, to the specification of Doctor Churchill Sibley, and erected in the large concert hall in the Goldsmiths' Institute, New Cross, containing 60 stops and 3,107 pipes, is blown by means of electricity, the apparatus having been designed and constructed by Messrs. Easton & Anderson, 3, Whitehall Place, S.W., and Erith Iron Works, Kent. This method was adopted as being the simplest and most efficient way of enabling the engine belonging to the Institute and used for pumping, driving the workshop, &c., to supply the power for blowing, and do away with a special prime mover, which would have been for many reasons objectionable. The gear consists of three cast iron blowing cylinders 17 inches diameter by 24 inches stroke, placed side by side on a framework made of rolled joists secured to the concrete floor of the blowing chamber, which is situated at one end of the gymnasium. Two of these cylinders supply one regulating reservoir with wind at 5 inches pressure, and the third cylinder supplies a second with wind at 10 inches pressure, from which suitable trunks are led to the organ. The pistons of the two low pressure cylinders are worked by a double throw crank-shaft driven by a worm and worm-wheel, which is enclosed in a cast-iron casing, the worm being connected by a coupling with the spindle of an electromotor capable of giving out ordinarily about 2½ H.P. The piston of the third cylinder is worked by a single throw crank-shaft with a similar worm gear and another motor of the same size. The motors always run at an approximately constant speed, and, when the reservoirs are full, automatic bye-passes are opened between the ends of the cylinders, and the air is simply passed backwards and forwards until the reservoirs fall again and shut the bye-pass. Switches are arranged with suitable resistances close to the organ keyboard, by which either or both of the motors can be started, and which also provide a means of regulating the speed to some extent. The conductors are led from the motors and switches to a space near the engineering workshop, where they terminate in a switchboard having cut-outs and a voltmeter on it, connected to the generating dynamo, which is driven by a countershaft and belts from the workshop shafting. It is capable of giving an output of about 100 volts and 50 amperes. The arrangement works very satisfactorily and requires very little attention.

Electric Light for the Birmingham Gaiety Theatre.—The *Birmingham Post* states that Messrs. B. Verity and Sons have been instructed to instal a complete plant for the electric lighting of this hall, both inside and out. For the present the installation will consist of a 7 H.P. Crossley gas engine, a dynamo, 5 arc lamps of 2,000 candle-power each (one of them being a special search light in place of the lime light on the stage), some 30 powerful incandescent lamps on the float, controlled by apparatus similar to that supplied for the Royal English Opera House, London, and numerous incandescent lamps in the bars and throughout the building. The plant, when finished, will be one of the most complete in the district, Mr. Barnard having gone to a considerable expense over the matter, the figures reaching to something under £1,000.

Solidified Petroleum Fuel.—A demonstration was given lately of a petroleum fuel prepared under Chenall's patents as a substitute for coal for marine, industrial, and domestic purposes. It was claimed for the new preparation that the process of conversion is very simple and occupies only about half an hour. The petroleum is mixed with about 20 per cent. of other material and during this process certain bye-products are obtained of sufficient value to cover the cost of solidifying the oil. The name of the company owning and working the patents is the Solidified Petroleum (Pioneer) Corporation, Limited, of 31, Queen Victoria Street, who, we have no doubt, would be happy to answer enquiries from anyone interested.

Hull Electric Lighting Contract.—We understand that Messrs. Crompton & Co., Ltd., have received the contract from the Hull Corporation for the construction and laying of electric mains in the streets in the prescribed area. The tender comes to over £8,000. The work will be commenced at once, and Mr. B. H. Jenkinson, who has recently completed the Southampton mains, has the carrying out of the contract on Messrs. Crompton's behalf.

Country House Lighting.—Colonel Sir Edward Hill, K.C.B., M.P., has given Messrs. Drake & Gorham instructions to instal the electric light at his residence, Rookwood, Llandaff. The motive power will be a gas engine placed in a building to be erected at the back of the house. The current will also be taken overhead on posts through the plantation for the lighting of the stables.

The Electric Light in the West End.—Messrs. Gilbert & Co., of Hanway Street, W., are carrying out an installation of the electric light at Gatti's Restaurant, 52, Strand, W.C. Messrs. J. G. Statter & Co., of Victoria Street, S.W., are carrying out an installation in some new premises situate in Ashley Place off Victoria Street, S.W.

Tenders Wanted.—Submarine Cable to the Azores.—The Portuguese Government are inviting tenders until the 25th inst., for the construction and working of a cable between Lisbon and the Azores. Provision must also be made for the continuation of the cable to the Flores Island and North or Central America, and also for constructing a cable from Lisbon to a point of the Continent of Europe.

Tenders Wanted.—Dundee.—The Dundee Gas Commissioners are inviting tenders for the execution of contracts for the supply of boilers, engines, dynamo machines, accumulator batteries, street mains, &c., in connection with the proposed supply of electric light. Further information will be found amongst our advertisements.

Tenders Wanted.—Abroad.—The Indentors Union, Limited, are inviting estimates, &c., for a complete set of machinery for supplying 100 incandescent lamps. For further information see our advertisements.

Electric Lighting at the Mansion House.—During last week some experiments were carried out at the Mansion House by the Planet Electrical Engineering Company, Limited, with the object of permanently lighting the stained glass windows in the Egyptian Hall by night.

King, Mendham & Co.—Messrs. King, Mendham and Co., Electrical Engineers and Contractors, Western Electric Works, Bristol, have appointed Mr. W. B. Allison, 12 Fenchurch Street, E.C., their sole London agent.

Poole & White.—Mr. Thos. G. Poole informs us that he has resigned the managing directorship and secretaryship of Poole and White, Limited, at the same time retaining his interest in the company.

Pilsen's Photographer's Lamp.—We are asked to mention that the makers of this lamp, described in our last week's issue, are the Pilsen Electric Company, 80, Leather Lane, Holborn.

CITY NOTES.

Chelsea Electricity Supply Company, Limited.

The annual meeting of the shareholders of the Chelsea Electricity Supply Company was held on Thursday, at the Central Station, Draycott Place, Chelsea. Mr. J. Irving Courtenay presided.

Mr. S. J. Cluer, the Secretary, read the notice convening the meeting.

The report, which appeared in last week's Electrical Review, was taken as read.

The Chairman, in moving the adoption of the report and balance-sheet, said: The accounts before you represent the result of the second complete year of work, and you will, I think, agree with me that, considering the numerous obstacles a pioneer company is bound to encounter, the result is encouraging. The observations I have to make, and the comparisons I shall offer will, I trust, confirm you in this opinion. No one who realises the difficulties of working up a business of this nature will be surprised at our not being able to pay a dividend as yet in addition to the debenture interest, but we are now in a fair way of earning some return on the ordinary share capital. The gross revenue is 67½ per cent. more than that for the preceding year, but the gross profits are more than three times as large as those of 1890. These profits have, as you will observe, been mainly used for the payment of debenture interest and the extinction of the suspense account. Now, although the improvement is great, we are convinced that a still greater improvement can be made. Much has already been done of which the benefit is scarcely felt in these accounts, as the alterations put in hand early in the year were not completed until December. The result of this was, that during the greater part of last year the work was not only carried on under the old disadvantageous conditions, but the difficulty of supply was also enhanced by the alterations going on at the same time. Notwithstanding these adverse circumstances, the improvement in the last three months of the year, as pointed out in the directors' report, has been most marked, the current having been produced for the last quarter of 1891 at 33 per cent. less than the average of the previous nine months. I am, however, happy to say that our resident engineer, Mr. Talbot, has successfully coped with all the difficulties of the situation, and has maintained an efficient supply. I need not go into the details of the capital expenditure, as the items are set forth fully in the balance-sheet; but as an indication of the economy with which the capital has been used, I may mention that on December 31st last the expenditure for each lamp installed was only £2 14s. 6d., and it is now less. During the last two years we have obtained an increase of about 20,000 lamps, the total number now standing at over 30,000. The lamp density in the area supplied by the company is extremely good. At the end of 1891 there were 4,583 lamps installed for every mile of street in which the mains are laid, or 2·6 lamps per yard. The proportion of houses lighted in the streets in which mains are laid is one-quarter to one-third of the total number of houses. The plant is all in good working order and the cost of maintenance has been moderate. The maintenance of generating plant is 3 per cent.; of buildings just over ½ per cent.; of mains ½th per cent.; and of meters 2½ per cent. on the capital expenditure. The maintenance of accumulators and accessories amounts to about 2½ per cent. of the capital expenditure on them, but I may remind you of what I have stated on a previous occasion, that the maintenance of accumulators includes the complete renewal of the

plates—which are practically the only parts that wear out. The capacity of the present plant in ordinary weather is over 40,000 lamps, but as in this part of London particularly we have to take into account prolonged foggy weather, we have to allow a large margin, which reduces the safe capacity to, say, 33,200 lamps. By an expenditure, however, of about £1,600 this capacity could be increased to 36,200 lamps, and by laying out a further sum of about £1,000, to 38,350 lamps. The introduction into our system of the continuous current transformer, which was initially arranged as part of the system by Mr. Frank King, and which was viewed by some authorities as somewhat in the nature of an experiment, has proved a permanent success. Apparatus of this class had not previously been used for the purposes of general electricity supply, and it is gratifying to note, after two years' experience, that they work most steadily and efficiently, and at a very low figure for maintenance. These are now made by the Electric Construction Corporation at Wolverhampton. We have not carried out the extension of our mains as contemplated when I last addressed you, and, consequently, our income has not been as large as was then estimated. I will now endeavour to give you an estimate of the revenue for this year. Taking only the additions to the lights which we now have in view within our present area, and calculating on the basis of the the results of 1891, the gross revenue from current alone should amount to over £13,000, as against £9,681 for 1891, an increase of 34 per cent. without entering upon fresh territory. A profit of 2½d. per unit on this output would realise a sum sufficient to pay debenture interest on, say, £35,000, and a 4 per cent. dividend on the share capital. But we look for still better results. There is yet room for a substantial increase in the number of lamps where the mains are laid; new blocks of houses are rising, and we know of two estates in the neighbourhood of our mains which are about to be rebuilt. As I have before mentioned, nearly all new houses in this district are wired for the electric light. This observation bears on the question that has been somewhat fully discussed—the reluctance to take the electric light amongst a number of people who do not care to incur the expense of having their houses wired, especially where the leases have only a short time to run. That very difficulty does not meet us so much in Chelsea as it does in the older parts of the metropolis, where rebuilding is not going on as it is in Chelsea. During the first quarter of the year we have obtained an increase of over 2,500 lamps. The revenue account for that quarter fully bears out the estimate I have just given you of the revenue for the current year. Our figures are based on a return per 8 C.P. lamp of 9s. per annum, an amount likely to be increased as more shops and trading premises come on the circuit. We are still giving our close attention to improvements in economy of working, and are continuously taking careful tests of results. The supply has already been acknowledged to be the best for the consumer, and it is second to none in steadiness and in quality; and we believe that a system of supply which is popular with the consumer must succeed in the end in giving satisfactory returns to the shareholders. I will conclude by moving the adoption of the report and accounts.

Major-General WEBBER seconded the motion, and said he wished to draw attention to the extremely characteristic district they had to deal with. Its returns must not in any way be put in competition with the revenues from such districts as St. James. Here the lights were added by 20 and 30 at a time, whilst in places like the City, Bond Street and Regent Street, they come on by 50, 100, and even 500 at a time. There was one point which the chairman would permit him to supplement with regard to his statement. He said that the cost of the maintenance of accumulators and accessories amounted to about 2½ per cent. of the capital expenditure upon them. That was the fact as applied to the past year, but he (the speaker) would like to point out that the average was between 5 and 6 per cent. per annum, and this would be regarded by all electrical engineers as a very reasonable one.

Mr. HICKLIN asked why it was that the meetings of the company were not held in the City.

The CHAIRMAN: We considered this question, Mr. Hicklin, of meeting in the city, but shareholders and customers live round here, and we thought it was unnecessary to go to the expense of hiring a place in the city. We thought it would be just as well to have the meeting in the offices of the company and in the central station of the company. I quite approve of General Webber's desire that there should be nothing misleading in my statement, but I believe the statement I made is precise in the fact. I was dealing with the accounts for the past year, and you may check them for themselves. My duty as chairman will be to deal each year with the figures for the year. We know what a vexed question amongst experts is the life of accumulators. But we are gaining experience, and each year we shall deal with this matter in what seems the best way. I think we are in a position to offer an opinion as well, perhaps better, than most people. We do not fear the maintenance of accumulators. Next year, and the year after, it may be greater, but when that comes we may deal with it. We certainly won't put down an estimated sum for depreciation. What we will do is, put new batteries or new plates in every year. We won't allow anything to depreciate, but will keep the whole of the batteries and plates new each year, and charge that to the accounts for the year. I think the shareholders will agree with me that is the fairest manner of handling the question.

The retiring directors, Major-General Webber and Mr. Daniell, offered themselves for re-election. Their names were proposed by the CHAIRMAN, and respectively seconded by Mr. HICKLIN and Mr. JILLINGS, and they were both re-elected.

Messrs. Cooper Bros. were re-appointed auditors on the proposition of Mr. HICKLIN, seconded by Mr. JILLINGS.

The meeting closed with a vote of thanks to the Chairman for presiding.

West India and Panama Telegraph Company.

THE 30th ordinary general meeting of the shareholders of the West India and Panama Telegraph Company, Limited, was held on Tuesday, at Winchester House, Old Broad Street, E.C. Mr. C. W. EARLE, Chairman, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, expressed the deep regret the directors felt in the unexpected death of their esteemed colleague, Mr. William Ford, which took place on Saturday last. Mr. Ford for the last 18½ years had taken an active part in the affairs of the company. He (the Chairman) did not think any shareholder who was present at the meeting in November could be surprised at the result of the last year's working. The board then felt that a very serious effect would be produced on the company by the unjustifiable competition established in the French islands of Martinique and Guadaloupe. When he used the word unjustifiable, he referred to the conditions of the telegraphic business and the field the French company had elected to invade. They (the West India Company) who had carried on the work in the West Indies knew how insufficient the telegraphic requirements of that region were to maintain one company even in fair prosperity. Those requirements had been practically fulfilled at the cost of the shareholders of their company, for they had never received a fair return on the capital invested. The only consolation, although a poor one, was the fact that the French company were suffering from the competition to a greater extent than their company. Turning to the accounts for the past half-year, the expenses under abstract A showed an increase of £62, almost entirely attributable to additional legal expenses. Under abstract B there was a diminution of £546 from various causes. There was one satisfactory omission from the debt items in this abstract, the charge for the hire of sloops during interruption of cables. This was the first time the company had presented an account without a charge under this head, and it was also the first half-year they had received the subsidies in full. Abstract C was not so satisfactory, but it must be remembered that the account compared with an exceptionally low account in the preceding year. The company had had many heavy repairs during the period covered by the report, but the cost of repairs charged to revenue in 1891 was rather below the average cost during the past ten years, although the cables were much more expensive than formerly. He was told that the average for the last ten years of their cable repairs charged to revenue was £26,174, but for the year 1891 the cost was £24,900, although during the last half year there was a rather serious increase. The laying of the new cable between Trinidad and Demerara completed their duplication, and all the colonies served by the company were now connected by double lines of cables. The company issued the £80,000 worth of debentures without incurring any expense for commission or discount. The hopes the Board had entertained of the sugar crop in the West Indies this year turning out very good had proved disappointing, and this, of course, reacted on their company. He concluded by moving the adoption of the report and accounts, and the payments of dividends of 6s. per share on the first preference shares, 6s. per share on the second preference shares, and sixpence per share on the ordinary shares.

The report was unanimously adopted.

The retiring directors were re-elected and the re-appointment of the auditor confirmed.

A cordial vote of thanks to the chairman and directors, and an expression of sympathy from the shareholders in the loss the company had sustained in the death of Mr. Ford, terminated the proceedings.

Oriental Telephone Company, Limited.

AN extraordinary general meeting of the members of this company was held at the offices of the company, 14, Austin Friars, London, E.C., on Thursday the 12th instant, Mr. WILLIAM ADDISON in the Chair.

The Secretary, Mr. ALEX. B. CHALMERS, read the notice convening the meeting.

It was moved by the CHAIRMAN, seconded by Mr. B. ST. JOHN ACKERS, and unanimously resolved:—"That the following resolution, passed at the ordinary general meeting of the company held on the 27th April, 1892, be confirmed as a special resolution, viz.:—'That the name of the company be changed to The Oriental Telephone and Electric Company, Limited.'"

Reuter's Telegram Company.—Notice is given that the 28th ordinary general meeting of the shareholders of this company will be held on Wednesday, the 1st proximo, at noon precisely, at the company's offices for the reception of a report and balance sheet from the directors, the declaration of a dividend, and the election of a director and auditors.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 13th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,635.

The West India and Panama Telegraph Company. The receipts for the half-month ending May 15th were £2,666, against £3,155.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, May 12th.	Closing Quotation, May 19th.	Business done during week ending May 19th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	102⅜	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	48½— 49½	49½	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	89 — 90	88 — 89	90	88½
2,849,510*l*	Do. do. Deferred	Stock	11⅜ — 12¼	11¼— 11⅜	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	10½— 11	10½— 11	10⅝	10½
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	102⅜	..
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	107¼	105
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3 — 3½	3½	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2 3/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7¼— 7¾	7⅞— 8¼	8	7⅞
$7,716,000	Commercial Cable, Capital Stock	$100	158 —163	158 —163	159½	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛— ⅜	⅛— ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅜	5⅛ — 5⅜	5 1/16	5⅛
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	3¼	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11½— 11¾	11⅞	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅜— 15	15	14⅜
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜	15¼— 15⅜	15⅜	15⅜
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108	107¼
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	110½	109
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	14⅞— 15⅛	15¼	14 15/16
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	103½	103¼
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102⅜—105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —103	101 —104	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅜— 6¼	5⅜— 6¼	6 1/16	5⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅛— 1⅜	1⅛— 1⅜	1¼	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2¼— 2⅜	2 9/16	2 7/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1½— 1⅝	1⅜— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10½— 10⅝	10½— 10⅝	10 5/16	10⅛
180,042	Do. do. 6 p. c. Preference	10	15½— 15⅝	15⅝— 15⅝	15 9/16	15½
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜— 19½xd	18⅜— 19½xd	18 13/16	18⅝
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜— 8¼	7⅜— 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	19½— 20½	20¼	19⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	105	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3⅜— 3½	3 7/16— 3 9/16	3½	3½
10,000	Do. do. fully paid	5	5 — 5⅛	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7xd	6 — 7xd	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½— 8xd	7½— 8 xd	7 1/16	7⅜
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4½	4 7/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13½	13¼
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12¼— 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108¾	108¼
250,000*l*	Do. (issued at 5 p.m., all paid)	...	104 —106	104 — 106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	7/16— 9/16	7/16— 9/16	...	...
9,000	Reuter's Limited	8	5½— 6½	6 — 7	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	9	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¾— 8¼	7¾— 8¼	8⅛	7 15/16
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116½	116
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¾— 4¼xd	3¾— 4¼xd	4⅛	3⅞
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43⅜	43
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	1½— 2½	1½— 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3¼— 4½	3 5/16	3¼
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9½— 10	9⅛— 10	9⅞	9 9/16
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅜	...
30,364	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3¼— 4	3½	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1½— 1⅝	1⅝	1½
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10 7/16	10⅛
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 —103	102 —106	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —119	115 —119	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅜	6½— 7	6 1/16	6⅝

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—7 per cent. Preference Shares of £5 (fully paid) 5¾—6¾.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5¾—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Foundors' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—½.—Do. Debentures, 100—½.—Woodhouse & Rawson Ordinary of £5 £2 10s. paid), ¼—⅜.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

GUTTA PERCHA.

A PAPER READ BEFORE THE SOCIETE D'ENCOURAGEMENT BY MR. SERULLAS.*

AFTER thanking the Society for pecuniary aid he had received, Mr. Sérullas proceeded to deal with the practical results of his last mission from the point of view interesting to the electrical industry. At a future meeting he will briefly review the whole of his researches in the Malay Peninsula.

The situation with regard to the important question of the supply of gutta-percha was serious. It resulted, on one hand, from the treatment of the trees which furnished the gum so indispensable in submarine telegraphy, and, on the other hand, to the rapidly increasing difference between the supply and the demand.

The method practised by the natives for the extraction of the gutta, consists in cutting down the tree, the new shoot of which, when it grows, does not yield gum until 10 years old. When the tree (*Isonandra Percha*) reaches the age of 15 or 16 years, the natives find the cutting of it scarcely remunerative. By felling all the trees, anything like the right age which are met with, after having ruthlessly destroyed all the fully grown ones, the native has for many years prevented the reproduction and multiplication of this valuable plant.

In 1854, when gutta-percha was first introduced, many of the trees were already old; those which now survive are for the most part decayed, the repeated cuttings to which they have been subjected having doubtless diminished their longevity.

There are still, however, half-a-dozen forests which the gutta-percha hunter, thinking by mistake exhausted, has forgotten, and in these propogation has been freely going on; but situated in districts which were the first to be opened to civilization and not of much value from the native's point of view they have no particular interest except as forests, and, besides, the mining industry is beginning to seriously injure them.

The crisis dreaded, with reason, by manufacturers of submarine telegraph cables, is close at hand. It can only be avoided by systematic cultivation, and by methodically utilising the last existing resources.

The work which Mr. Sérullas has just accomplished will secure a sufficient supply for the future, by providing means of renewing dried up sources, and starting plantations on a large scale in our colonies, and, thanks to a new process of extracting gutta from the trees, he bridges over the time necessary for these plantations to be of use.

By the existing method of obtaining gutta, the trees, when large and full grown, are cut and destroyed, and can only be of use again after many years of growth, but Mr. Yungfleisch, in May, 1888, suggested to Mr. Sérullas a method for extracting gutta from the *leaves*.

The experiments made in Malay by this explorer have been conclusive as to the possibility of extracting the juice, coagulated and unchanged, from the tree, without sacrificing the trunk. The raw material which was brought to Paris has just been analysed in the laboratory of Mr. Yungfleisch, under the direction and according to the advice of this expert. The results of this treatment by an entirely new process, have been as decisive as unforeseen. Not only is the extraction of the gutta-percha from the leaves most economical, but the yield is enormous.

Any Isonandra tree possessed of leaves becomes *ipso facto*, fit to be operated on. Without touching the trunk a proportion of pure gutta-percha can be obtained which, when dried, represents 8 or 9 per cent. of the weight of the raw material after dessication in an oven at a temperature of 100° C. (212° F.) It therefore follows that young trees as well as those which are so far decayed as to be useless under the native treatment, are capable of being very advantageously used, and a most satisfactory light is shown on the question. So long as the solution of this matter possessed the characteristic of being a very long operation, it was condemned to be dealt with by the Government; from now, however, private enterprise can step in. The plantations which will be started, and in which work the Government takes the initiative, can be worked in a comparatively short time, and French capitalists will be able to find in the utilisation of the last resources, which exists in the Malay forests, an investment which will return them some day or other large profits. The example provided by the culture of the Cincona, in various foreign colonies, is significant.

Would a French company promoted for such an enterprise be able to obtain, in the heart of the savage country of Malay, a sufficient quantity of raw material for immediate commercial and industrial operations? Certainly, because leaving aside the exaggerated figures which have been published relative to the importation of gutta-percha since 1843, and only taking into account, those duly authenticated, one is bound to conclude, that the number of trees still living amounts to over one million and a-half. In fact, between 1843 and 1891, a period of 48 years, the electrical industry alone has consumed 10,360,000 lbs. of gum, which can be proved to be Isonandra percha. By treating the felled trunk of a tree from 12 to 15 years old, only 3 or 4 ozs. of impure and wet gutta-percha can be obtained. It is impossible for a 30 year old tree to furnish more than about 9 ozs. At no period of its existence can a tree, if subjected to the native process, yield more than about a pound of gutta. After having yielded this maximum, the tree dies away, and in a little time, very little or no more juice can be obtained from the trunk, its whole life goes to the branches and leaves.

During 48 years, one tree can only be cut four times. It must be remembered that in the neighbourhood of Singapore, gutta-percha hunting was not started until about 1850. Taking it for granted that at the time of first cutting, every tree was in a condition favourable for the maximum yield, it is evident that each one has not been able to furnish up to now more than 1 lb. + 4 ozs. × 3 = 1 lb. 12 ozs.; to produce 10,360,000 lbs. has, therefore, required more than 5,600,000 distinct trees.

Local statistics and actual exportations, all agree in confirming the statement of Mr. Sérullas, to the effect that more than one-third of this number of trees is still in existence, that is to say, at least 1,850,000. These remaining trees, it is true, may not live very much longer, and their condition is such as to render them almost useless in the hands of the native; but if an adult tree, in full vigour, can furnish, without harm to it, and for a length of time, some 200 lbs. of dried leaves, every six months an old tree should at least have enough foliage to furnish two-thirds of this amount. A young tree of 4 or 5 years old, never gives less than about 6 lbs. of dried leaves. The leaves of a young tree, and of those recently cut down, are, curiously enough, larger and richer in gum than those of a large tree. The cutting of the branches, which at this age are few, seems in a short time to considerably increase their number. The trees easily lend themselves to grow as pollards. From a tree which to the native is valueless, *i.e.*, too old to permit of the usual treatment of the trunk, it is easy to gather a weight of leaves equivalent to 8½ lbs. of gutta-percha, thus in a single day, by simply taking the leaves off such trees, five times as much gutta can be obtained as the natives could possibly secure by operations extending over half a century.

A young tree of four or five years old, can for its part by simply picking its leaves, be made to yield some 9 ounces of gum, that is to say, just about as much as a 30 year old tree is capable of furnishing when its trunk only is treated. On the whole, there are, without doubt, in the Malay forests more than 1,500,000 trees, which will soon be permanently destroyed, and which, while of no value to the native, contain over 13,000,000 lbs. of gutta-percha. Even supposing that the stripped leaves will not be replaced by new ones, there is still a very satisfactory margin, and the enterprise should be a safe one. Gutta-percha of first quality is worth in the market of Singapore about 4s. per pound, and this gum would lose in the process of purification, 10 or 15 per cent. of its weight, which loss is represented by water and various impurities such as sand, bark, &c. Under the present state of things, various commercial intermediaries, make a profit which amounts to at least 3s. 4d. per lb., and adulterations are practised in the most barefaced manner.

By treating the leaves of the *Isonandra Percha*, a French company would be able to furnish from this date a large supply of gutta percha for our electrical industry, of an excellent and homogeneous kind, and plantations destined to rescue our submarine telegraph industry from foreign monopoly, will not have to be planted 15 or 16 years before they can be of use. Four years from the date of their planting each of the young trees will be worth as much, in the hands of the European, as an adult tree when left to the native of Malay.

* Translated from *L'Industrie Electrique*.

NEW PATENTS—1892.

8,242. "Improvements in and connected with electrically propelled vehicles." F. A. HASELWANDER. Dated May 2nd. (*Complete.*)

8,258. "Improvements in carrying or supporting electric collectors." M. H. SMITH and T. P. WILSON. Dated May 2nd.

8,265. "An improved globe or shade holder for electric, gas or other lamps." W. H. INGALL. Dated May 2nd.

8,267. "Improvements in electrical circuit arrangements and apparatus for telegraph message signalling." F. T. HOLLINS. Dated May 2nd.

8,268. "Electrical steering gear." G. S. GRIMSTON and A. H. DYKES. Dated May 2nd.

8,294. "The electric light advertisement." J. C. B. TAYLOR. Dated May 3rd.

8,367. "Improvements in incandescent electric lamps." J. R. HUGHES. Dated May 3rd.

8,385. "Improvements in electricity meters." W. F. TAYLOR. Dated May 3rd.

8,397. "Improvements in the method of and apparatus for transforming and distributing electric currents." F. A. HASELWANDER. Dated May 3rd. (*Complete.*)

8,399. "Electrical or galvanic braces." J. W. PARAMORE and H. THEAKER. Dated May 3rd.

8,408. "Improvements in electric incandescent lamps." I. CLIFFORD. Dated May 3rd.

8,447. "A new or improved holder for the globes or shades of electrical, gas and other lamps." R. G. EVERED. Dated May 3rd.

8,452. "Improvements in driving certain machines by electromotive power." A. CHAPMAN. Dated May 3rd.

8,463. "Improvements in electric arc lamps." C. COERPER. Dated May 3rd. (*Complete.*)

8,493. "Improved telephone transmitter." R. WHITEHEAD and A. DOXEY. Dated May 5th.

8,507. "Electric time-check, call-bell, and registering apparatus." C. MILES. Dated May 5th.

8,529. "Improvements in galvanic batteries." W. MOSELEY. Dated May 5th.

8,535. "Electrical hose signalling apparatus." W. FOWLER. Dated May 5th. (*Complete.*)

8,537. "Improved electric light switch." W. E. LANGDON. Dated May 5th.

8,556. "Improvements relating to alternating current electric machinery." O. PATIN. Dated May 5th.

8,572. "An improved galvanic element." H. BECKMANN, E. BECKMANN, and J. SCHMITT. Dated May 5th. (*Complete.*)

8,576. "Improvements relating to the measurement of electrical currents. E. H. P. HUMPHREYS. Dated May 6th.

8,611. "An improved electric alarm for show cases." R. C. KRUSCHKE. Dated May 6th.

8,638. "Improvements in electric mains." T. TOMLINSON. Dated May 6th.

8,642. "An improved holder for holding shades or globes of electric, gas or other lamps." E. F. CARPENTER. Dated May 6th.

8,663. "Improvements in the cores of electro-magnets for motors and other purposes." H. F. JOEL. Dated May 7th.

8,706. "Improvements in electrical fittings, such as ceiling roses and cut-outs." S. A. MOORE. Dated May 7th.

8,720. "Improvements in electric meters." W. T. GOOLDEN and S. EVERSHED. Dated May 7th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

4,468. "An improvement in casings for electrical switches, safety fuses, ceiling roses, and similar fittings." C. D. ABEL. (Communicated from abroad by H. Messing, of Germany.) Dated March 12th. Claim:—Securing the cover of an electrical switch or like fitting to the base by means of an inwardly projecting lip of the cover sprung over a caoutchouc ring of larger diameter held in a groove of the base, substantially as described.

6,847. "Improvements in printing telegraphs." S. R. LINVILLE and L. F. HETTMANSPERGER. Dated April 21st. Relates in general to a novel system of printing telegraphy, in which the instruments are capable of being operated either as transmitters or receivers, by alternating currents transmitted through a single line conductor from a source of electric energy located at a terminal station where the alternator and the apparatus for controlling the same are preferably located, yet nevertheless, the alternator and apparatus for controlling the same may be located in line at an intermediate station instead of at the terminal station. The instruments have each two type-wheels, with characters arranged in the same radial line on the peripheries thereof. Each instrument looped in a single main line conductor through said alternator operates either as a transmitter or as a receiver without the employment of hand switches, or other devices for directing the current, or changing the organisation of the instruments to adapt them for use as transmitters or receivers, or *vice versâ*. The impressions are effected by means of a local battery located at each instrument. 171 claims.

7,778. "Improvements in or connected with electric conductors." W. P. THOMPSON. (A communication from abroad by J. B. Williams of America.) Dated May 5th. Consists in placing, around the conductor, and imbedding in the dielectric, a structure, which is termed a "centreing device," composed of suitable fibrous material saturated with a suitable insulating material, which is applied thereto by means of heat, or in solution in a suitable solvent. 5 claims.

9,073. "Improvements in electric railways." J. F. MUNSIE. Dated May 28th. Consists in substituting for the permanent trolley track-way a track-way made up of separate sections normally in an upright position and out of contact with the feeding conductor, said sections being adapted to be brought into electrical connection with the feeding conductor by means of a trolley or trolleys upon the car, so as to continously supply the car motor circuit from the feeding conductor. 10 claims.

9,876. "Improvements in telegraph block systems of railway traffic control." D. C. COOMBES and W. ROWE. Dated June 10th. Has for its special objects, first, to provide an automatic alarum in the signal boxes at either end of the block section should a train or engine in error advance "against the block," and to provide an additional or error signal which may be manipulated by either signal man at the ends of the section to warn the driver of such a train or engine of the fault or error; secondly, to provide means by which the telegraph signal transmitter or "block instrument" is locked in position, so that after the train, having been taken on to the section and the signal man having given his telegraphic message to such effect, said signal man cannot give the telegraphic message "line clear" until the said train leaves his said section; thirdly, to provide means whereby upon movement of a points lever so that the train will be shunted into a siding, the lock of the block instrument may be released by the advance of the train a pre-determined distance into such siding; and, fourthly, where it is necessary for a train to cross over to the other line of rails to enable a following or through train to pass it, to provide means in such sections whereby alarums will be given in the signal boxes. 7 claims.

11,133. "Improvements relating to dynamo-electric machines and electric motors and to apparatus connected therewith." H. H. LAKE. (Communicated from abroad by the Crocker Wheeler Electric Motor Company, of New York.) Dated June 30th. Consists in revolving the commutator brushes in the proper direction away from the neutral position so as to cause the magnetism developed in the armature by the armature coils to oppose or annul that developed in the pole pieces of the field, and by constructing the machine so that the magnetism in the armature or the magnetising effect of the armature coils is very intense and that of the field comparatively weak. 6 claims.

11,144. "Improvements in printing telegraphs." H. VAN HOEVENBERGH. Dated June 30th. The object of the invention is to provide a simple and reliable instrument which can print upon a slip of paper, or equivalent material, intelligence transmitted from a distance without danger of disarrangement of its parts by continued or severe working; that shall contain no superfluous working parts; that shall not be easily affected by induction, and that may be operated by a single main battery placed at any point in the line. The transmitting instrument is under the control of the receiving operator as well as the transmitting operator, so that the former may arrest its action whenever he desires. 9 claims.

11,201. "Improvements in apparatus for telephonic communication." J. SACK, E. VON MALTITZ, and P. ZIESEL. Dated July 1st. Relates to an apparatus which, when employed in connection with a telephonic system with a number of different stations, enables communication to be established between any two of those stations independently, and in such a way, that the remaining stations are completely disconnected, and are consequently unable to interrupt the conversation taking place between the two stations which are in communication with one another, or to overhear the conversation which is being interchanged between them. 5 claims.

11,473. "Improvements in alternating current electro-magnetic motors." H. H. LAKE. (Communicated from abroad by Nikola Tesla, of New York.) Dated July 6th. Consists in a novel arrangement applicable to motors, in which the current for one of the energising circuits is obtained by induction from the other, and also in a means for increasing the flow of current in the closed induced armature coils of any form of alternating current motor in which such coils may be present, particularly in what are now known as the Tesla motors. The first feature above referred to is the placing in the secondary or induced field or energising circuit of the motor a condenser, adjusting it so as to neutralise the self-induction to the desired extent, and to secure between the primary and the secondary currents the proper difference of phase for the most economical operation of the motor; and the second is the interposition of a condenser in the induced, or what is otherwise the closed circuit of the armature. 5 claims.

11,519. "Improvements in diaphragms for electric cells." E. A. LE SUEUR. Dated July 7th. Claims:—1. A diaphragm for an electric cell consisting of or comprising a layer, sheet or film of coagulated albumem, substantially as described. 2. A diaphragm for an electric cell consisting of a layer, sheet or film of coagulated albumen combined with supporting or strengthening material or materials, substantially as described.

11,746. "Improvements in telegraphic apparatus." F. VAN HOUTEN. Dated July 10th. Relates to a printing telegraph. 5 claims.

12,069. "Improvements in electrodes for secondary batteries." H. D. FITZPATRICK. (Communicated from abroad by K. F. Schöller and R. H. Jahr, both of Germany.) Dated July 16th. Consists in constructing an electrode of a grating or recessed plate, which carries the active substance and is formed with or connected to a common base or support. The active substance, which is supported on the grate, is so arranged that it projects out from it. 1 claim.

12,455. "Improvements in electric locomotives." J. WETTER. (Communicated from abroad by H. Bonneau, of Paris.) Dated July 22nd. Relates to an arrangement of the parts of the locomotive so that as great an adhesion to the rails as possible is obtained. 2 claims.

19,076. "Improvements in electric safety fuses." W. M. MORDEY. Dated November 24. The fusible conductor, which consists of a thin wire, is supported in a glass tube or other suitable vessel or box. This tube or vessel is then partly or wholly filled with finely divided or pulverised non-conducting or badly conducting material, preferably incombustible or non-inflammable, such as dry chalk, marble, bath brick, sand, mica, emery, asbestos, or the like, this material being made to cover and surround the fuse wire or strip. 2 claims.

CORRESPONDENCE.

Mercurial Poisoning.

To those whose occupation necessitates the use of mercury, your article in your issue of the 13th inst. must be very interesting, but I beg of you to give me a little space to correct the idea that Mr. Powell is the originator of such treatment. Twenty-five years ago when I took some interest in the study of medicine, to my certain knowledge iodide of potassium was in frequent use for the eradication of mercury from the human system, which had been treated with the latter mineral in the first instance as a remedy for a disease which must be nameless here. In using potassic iodide some degree of caution is necessary, or symptoms of catarrh will be very marked, and, moreover, its continued use is very debilitating.

F. E. Everard.

May 14th, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

Domestic Telephones.—(*Continued from page* 622.)

The only advantage obtained by using systems similar to those described in our last issue is, that they may provide for a larger number of points being connected than is mechanically practicable with the pointer form of automatic switch. None of the switches referred to appear to afford privacy of communication, as it will be seen that a third or fourth telephone may either by accident, or designedly, be connected to a line already occupied, and the conversation overheard. The General Electric Company exhibit a switch designed to get over this defect, and which permits of the different stations being called up irrespective of the position of the pointer at the station called. The distinctive feature of the arrangement is, that it enables any two stations to converse together, if desired, without the possibility of being overheard by others. For this purpose a secret switch is provided, and by bringing this into use any two stations may employ their direct wires as a metallic loop for private conversation, discarding temporarily the use of the common return wire or earth. The latter is, however, still available for use by any of the other stations requiring simultaneous communication.

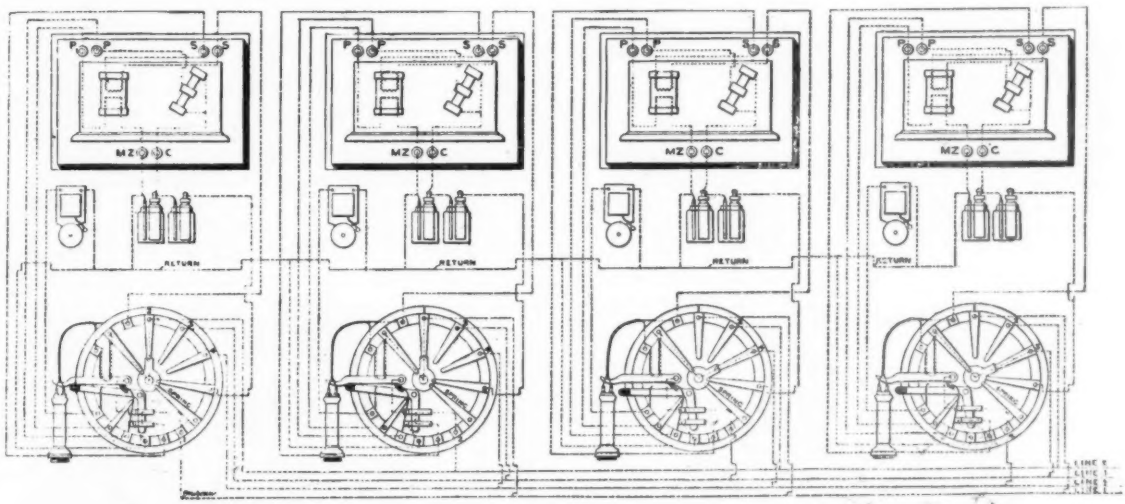


FIG. 8.

Permanent contacts, marked "spring," are provided to prevent the apparatus being at any time left disconnected. The connections for four stations are shown in fig. 8. Stations 1 and 2 are shown communicating by means of a metallic circuit, and stations 3 and 4 are using the return wire normally common to all the offices on the system. The point of novelty in the arrangement is the secret switch lever, which is actuated by hand, at the will of the operator, to bring into use the metallic circuit, but is restored to its normal position when the conversation is completed, by the act of hanging up the receiver upon its suspending hook. The invention (which is patented) is by Mr. T. B. Sloper; it requires the same number of lines as other intercommunication systems of this class, that is, one line for every station, which must be extended to every other station, in addition to a return wire or earth, common to all. In the diagram the telephones should be understood to be off the hooks in each case.

Microphones.

Of microphone transmitters, specimens of almost every type in general use are to be seen at one or other of the stalls. The principal varieties are represented by the Hunnings, the Blake, and the Gower-Bell. The extensive every-day employment of each of these forms is evidence of their general efficiency, but it cannot be said that either is in itself perfect. The records of the Patent Office furnish abundant evidence of efforts made to improve these various forms, but the greater efficiency obtained from instruments of recent manufacture is due rather to the closer attention which has been given to details of construction than to any distinct departure from the original designs. The Hunnings is liable to develop imperfect transmission, owing to the granulated carbon becoming consolidated, and in nearly all the forms of this transmitter provision is made for re-distributing the granules, either by turning round the case in which they are enclosed or by detaching it from the frame and shaking in the hands. The weak point of the Blake transmitter is the adjustment which it requires. If this is not accurate, the contact between the platinum stud and the carbon button is liable to be broken, and this defect often displays itself when the instrument is employed for trunk line working, or for speaking between points connected through several exchanges, in which circumstances speakers are generally impelled to be more emphatic than is desirable. An objection is urged that the stooping posture which a speaker has to assume when using the Gower-Bell renders its prolonged use irksome, but it is free from defects which affect the speaking such as those referred to above. It is, perhaps, not too much to say that if a pencil transmitter, with a vertical diaphragm and devoid of adjustment were produced, it would speedily become a popular instrument. Messrs. Anders, Elliot and Chetham Strode have been working in this direction, and exhibit a novel transmitter having only one pencil mounted upon a vertical diaphragm. Fig. 9 represents the arrangement. Two carbon supports, S, S^1, are mounted upon, and at right angles to an ebonite diaphragm, E, and are securely attached thereto. Between the carbon blocks the pencil, P, is loosely supported. Upon the pencil a carbon disc, D, is carefully and accurately fitted. The object of this is to pre-

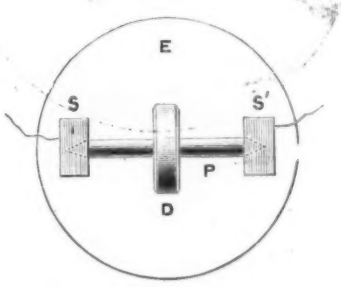


FIG. 9.

vent the pencil from jarring in its supports. The shape of the ends of the pencil is said to affect the efficiency of the transmitter, the best result being obtained when the ends are cone shaped, and the holes in the supporting blocks drilled to correspond. The transmitter gives satisfactory results, and is very suitable for domestic purposes, or for communicating over short distances. It occupies an extremely small space, and is very convenient to use. It is represented in fig. 4 (see last issue), fitted to the automatic switch apparatus.

A transmitter, having two pencils, and known as the "Johnson," is exhibited, mounted in various ways, by the General Electric Company. Fig. 10 illustrates the method

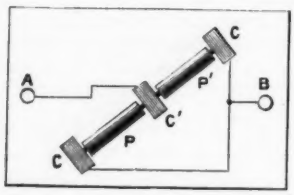


FIG. 10.

adopted for arranging and connecting the carbons. The two pencils, P, P^1, are loosely supported between three carbon blocks, C, C^1, C, mounted diagonally upon a pinewood diaphragm. The pencils are practically joined in parallel. A current entering at A would divide between the pencils, and leave at B. The diaphragm is mounted in a case at an angle similar to the Gower-Bell, and is protected from the action of moisture condensed on its surface during conversation by a thin sheet of mica, and from mechanical damage by a stout board forming a cover, and having a hole through which to speak in its centre. It is a very satisfactory transmitter for private lines, is said to give good results on exchange circuits, and possesses the merit of extreme simplicity of construction.

The International Electric Company exhibit a variety of transmitters by Mix and Genest, Berlin, amongst which is included their latest form, adopted by the German Post Office. Fig. 11 illustrates the instrument. M is the

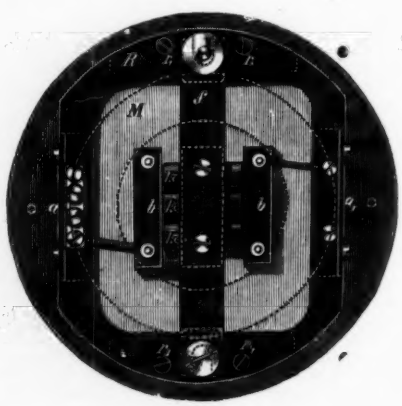


FIG. 11.

diaphragm of pine wood, attached to which are two carbon blocks, *b*, *b*, supporting the three pencils, K, K, K, in loose bearings. The improvement last introduced consists in attaching to the bar, *f*, three brushes of hog's hair in such a way as to press lightly upon the pencils, and prevent them rolling in their bearings. The bar, *f*, is pierced at its upper end by an oblong hole, through which the supporting screw is passed; at the lower end is an adjusting screw, the stem of which is eccentric. When the latter screw is turned, the bar, *f*, is moved up or down, and the pressure of the brushes upon the pencils increased or diminished. This method of adjustment seems susceptible of much finer gradations than the damper of cotton wool which it has superseded. The company also exhibits a variety of micro-telephones. Fig. 12 illustrates their general external appearance and fig. 13 is an underside view of the transmitter which has two pencils adjusted by a similar arrangement of brushes. It is chiefly used in connection with desk or table telephones, and gives very good results.

FIG. 12.

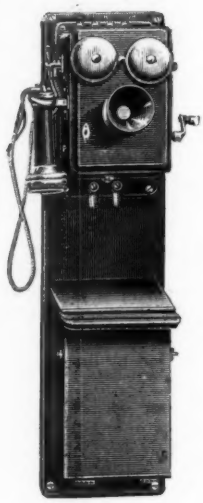


FIG. 14.

At the Consolidated Company's stand is exhibited for the first time a transmitter, intended for use upon the Mutual Telephone Company's system at Manchester. The diaphragm, which is vertical, is made of pinewood, and has a small disc of polished carbon attached to its centre on the inner side. A brass projection is fitted internally on the upper side of the case. A flat brass spring is extended from this projection, its lower end terminating opposite the carbon disc on

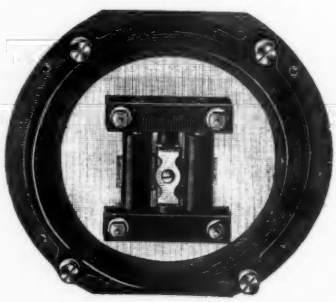


FIG. 13.

the diaphragm, and to this free end of the spring a small carbon button is attached. An adjusting screw, fitted to the projection which carries the flat spring, serves to regulate the pressure of the carbon button upon the disc attached to the diaphragm. The latter is circular, about $2\frac{1}{2}$ inches in diameter, and its edge is enclosed in an India-rubber ring. The transmitter resembles the Blake in general arrangement, and from a cursory examination it scarcely seems to be an instrument likely to yield very satisfactory results. It is provided with a special form of switch, by depression of the handle of which the subscriber effects a connection with the operator's wire to the exchange. When the handle is released it returns to its normal position, and the apparatus is connected to the metallic circuit for conversation with a distant renter.

The Western Electric Company exhibit a very powerful granular transmitter which they mount in a metal case suitable to fixing to various forms of apparatus. Fig. 14 gives a view of the instrument. It may be tested at the National Telephone Company's stall, where it has been selected for the use of the public who require trunk line conversations from the Exhibition.